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*Improving*  
HAWAIIAN  
SOIL RESOURCES



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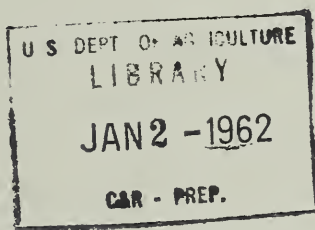
We have drawn on many places for information contained here-  
in. Census reports, statistical reports of Hawaii by the Hawaii  
Agricultural Extension Service, market studies, reports of Terri-  
torial Departments, manuals of Hawaiian Securities, annual re-  
ports of sugar plantations and many other sources have provided  
valuable references. Also personal conferences have furnished  
valuable interpretations that could not be otherwise obtained.  
Our thanks are extended to all who have given of their time  
to provide information on Hawaii's agriculture and its soils and  
water resources.





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**IMPROVING  
HAWAIIAN SOIL RESOURCES**

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JULY, 1958



X ✓  
U. S. DEPARTMENT of AGRICULTURE <sup>2</sup> U.S. SOIL CONSERVATION SERVICE //

J. H. CHRIST, Territorial Conservationist

For HONOLULU, HAWAII //



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*Hawaiian agriculture is progressive and modern, using the latest soil and water conservation techniques and up-to-the-minute machinery.*



# The Hawaiian Islands

Our islands were discovered by Captain James Cook in 1778. The archipelago extends some 1,400 statute miles northwest and about 200 miles southeast of Honolulu. Except for Maui, Oahu, Kauai, Molokai, Lanai, Niihau, and Kahoolawe, the central island group, the others that make up this extended island pattern are largely shoals, banks, reefs, atolls, and small islands. All except Midway Island are part of the Territory of Hawaii.



## Land areas of major islands:

ISLAND	SQUARE MILES	ACRES
Hawaii	4,030	2,579,000
Maui	728	466,000
Oahu	604	387,000
Kauai	555	355,000
Molokai	260	166,000
Lanai	141	90,200
Niihau	72	46,000
Kahoolawe	45	29,000

TOTAL 6,435 \*4,118,200

\*TERRITORIAL SURVEYOR'S FIGURES



A picturesque Kona coast place of worship.



One of Hawaii's beautiful ranch homes and its perfectly kept grounds.

The tremendous damage of uncontrolled flood waters extend beyond the farm and ranch to the town and village areas.



#### RAINFALL RATES

Serious land damage can be expected somewhere in the Islands every year. Rainfall records, showing intensities of 4 inches per hour, are frequent enough to warrant using in design computations. Highest rate recorded is 2.2 inches in 10 minutes or the equivalent of 13.2 inches per hour. Maximum for a full hour is 6.5 inches. Most rainfall recorded in a 24-hour period was 31.95 inches at Honomu, Hawaii on February 20, 1918 and 41.9 inches in 30 hours at Kilauea, Kauai in January 1956. These are the extremes in 40 years of rainfall records.

Except in leeward Hawaii, rainstorms seldom cause damage between May and September.

A high-intensity storm on November 18, 1930, caused the equivalent of 9.8 inches per hour of runoff from a 2.7 square-mile watershed.

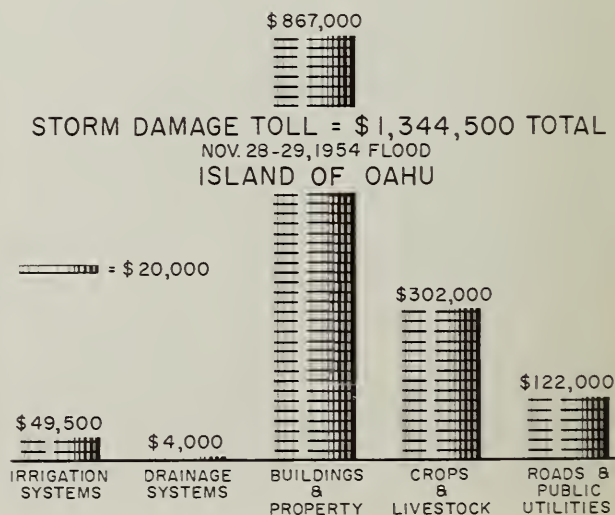


Uncontrolled water from a 4-inch rain in one hour tore great gashes in this field and deposited great quantities of silt.

#### STORM DAMAGE

Most unprotected land surfaces have a low infiltration rate. But soil permeability is usually high below the depth influenced by cultivation or trampling by livestock. Too often, however, watershed outlets to the sea are poor and inadequately maintained. Damage to crops, urban and industrial developments on the lowlands occur frequently enough to warrant improvement in water disposal systems and maintenance of natural outlets.

Storm damage is costly. Take, for example, the flood that hit Oahu, November 28-29, 1954. The storm damaged some 31,040 acres. This added up to 6,950 acre-inches of lost soil or 940,000 tons.







Overuse and concentration of livestock destroys the cover and brings about extremely heavy soil losses.

## EROSION LOSSES

Accelerated erosion in Hawaii dates back to advent of herds of domestic animals into the Islands. Natives had hogs, dogs, and chickens at the time of discovery of the Islands in 1778 by Captain James Cook. On this voyage of Cook's goats were introduced. Cattle and sheep were left on visits by Captain George Vancouver in 1793 and 1794. A kapu placed on the slaughter of the animals permitted a rapid increase of livestock. This caused major changes in an area that had developed without hoofed animals in the biota.

The heavy koa forest that originally clothed the steep lands failed to reproduce itself because of grazing of young trees. Trampling exposed the roots of older trees and they started to die out. Reports as early as 1840 speak of concentrations of herds and decrease of protective grasses. To

fight heel flies, flocks of sheep created stamping grounds on windy knolls. As livestock increased, outwash slopes became denuded and alluvial flats became dusty plains.

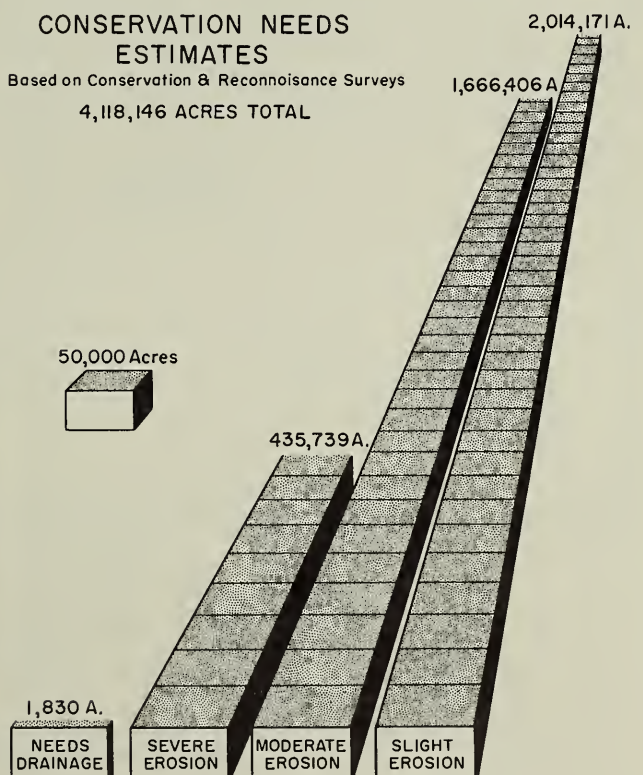
## CONSERVATION NEEDS ESTIMATES

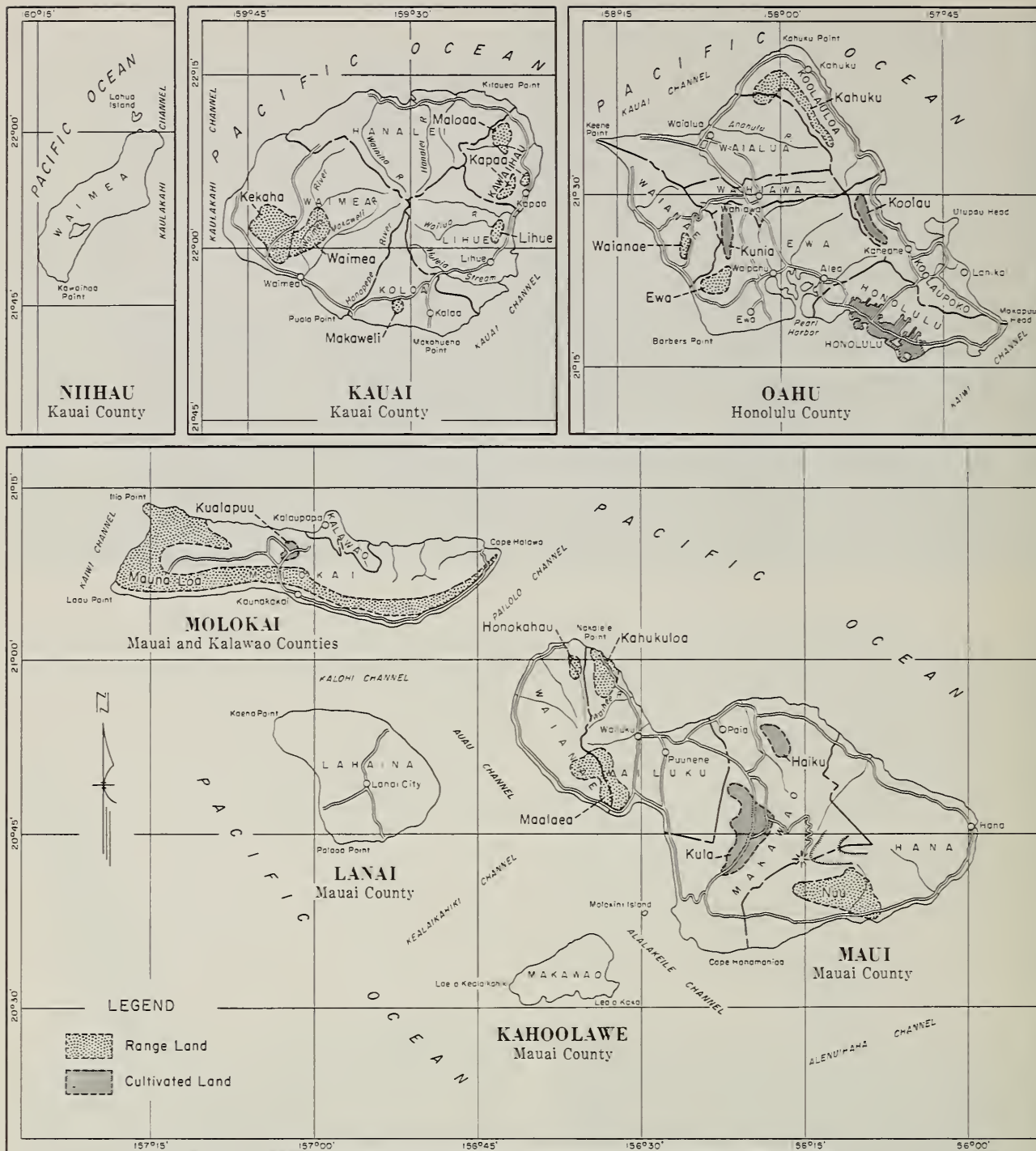
Based on Conservation & Reconnaissance Surveys

4,118,146 ACRES TOTAL

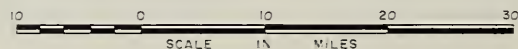


Up and down hill plantings of pineapples are fast disappearing from the Hawaiian farming scene. Here a heavy rain caused serious soil losses on newly planted field.

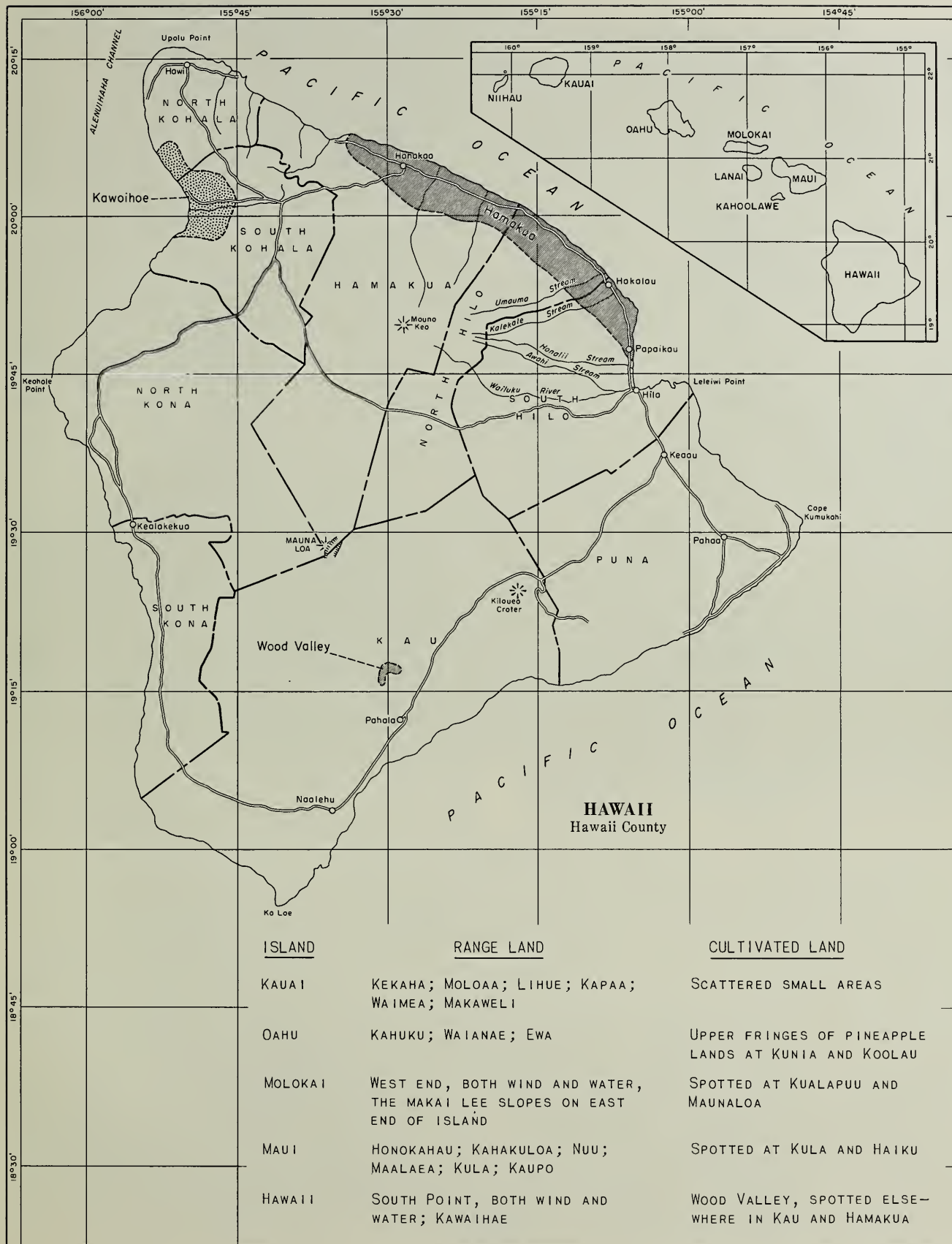




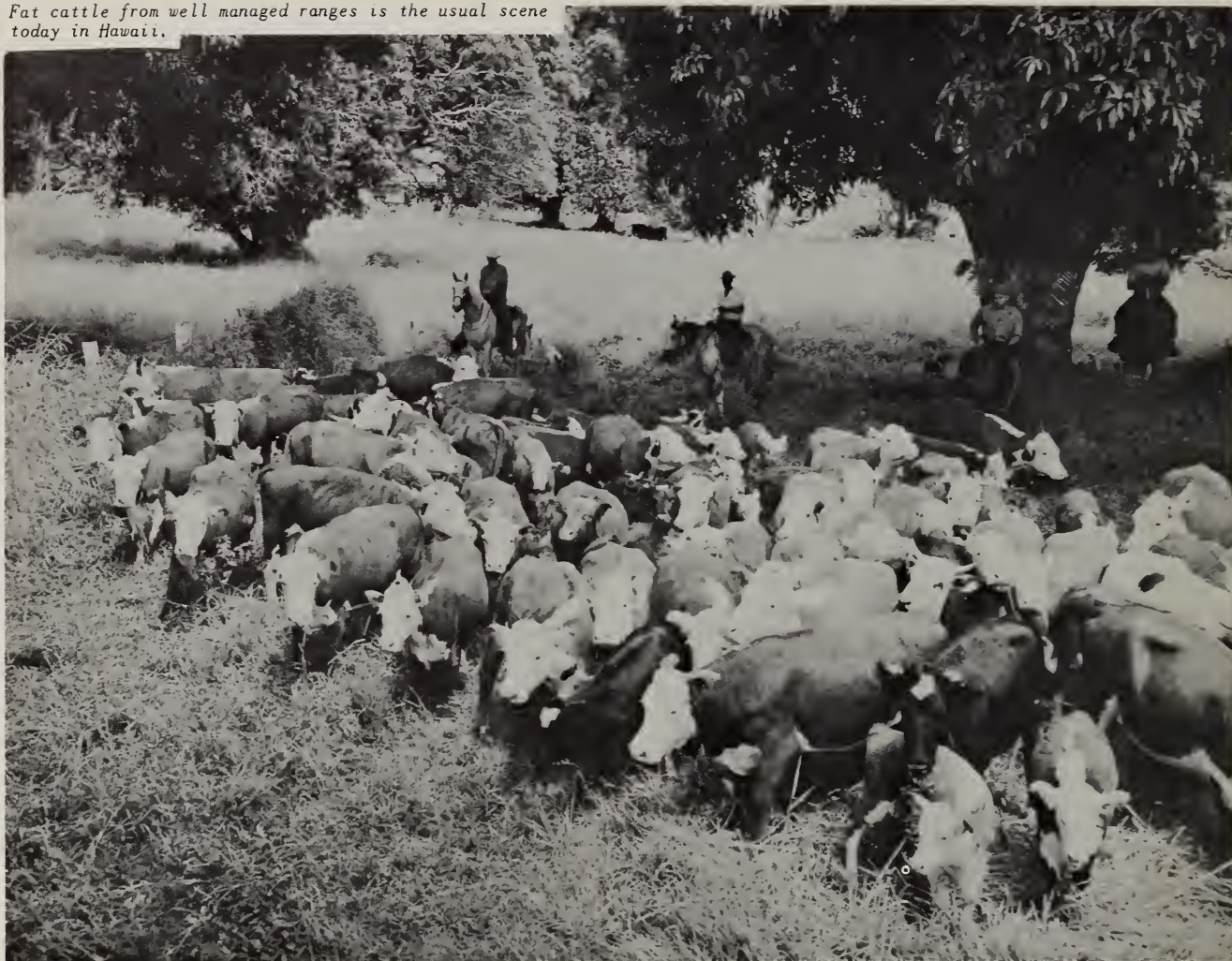
# SEVERELY ERODED RANGE and CULTIVATED AREAS HAWAIIAN ISLANDS







*Fat cattle from well managed ranges is the usual scene today in Hawaii.*



### RANGELAND EROSION

The most visible areas of erosion damage are on rangeland. Gullied slopes and spreading areas of rock outcrops show the losses that have taken place. In heavy storms, silt from these areas is carried into the ocean, often discoloring it several miles from shore.

Abandoned fields mark many areas formerly in pineapples on steeper slopes above present fields of pineapples.

### LAND USE CHANGES

Extensive studies are being made to determine the adaptation of potentially exportable crops. Expanding the production of truck crops for local consumption is not the answer for enlarging the Island's agricultural economy. It is reported that 300 acres of adaptable land would fill the needs of vegetables imported from the Mainland, excepting potatoes and onions. The local price of produce is influenced by delivered costs of imported vegetables. It provides a favorable price level for local producers, but also restricts the outlet for Island produce. Local distributors, buying on

the Mainland, invest in imported produce, while much of home-grown vegetables are sold on a commission basis. This situation, a "pocket market" restricts production to the consumptive ceiling of the Islands, less the Mainland importations.

Armed Services' purchases are doing much to strengthen local vegetable and fruit production. Considerable satisfaction is expressed with contracts made with Island produce organizations.

### CANE ACREAGE

In spite of the amount of eroded lands, little sugar cane acreage has been abandoned from that cause. Plantations that have ceased operations have done so largely because of climatic and economic conditions rather than soil losses. This does not mean that erosion is not a threat to the cane lands. The soil mantle on the steeper slopes in higher rainfall belts is gradually being thinned. Present field harvesting methods bring large quantities of soil to mills with the cane. This, too, is a direct loss from the fields.

Some soil is saved, particularly at mills having hydroseparators or other settling devices. Other





*Piles of silt removed from flooded irrigation ditches after a flash flood on an unprotected field.*

mills desilt the wash water in rocky areas or gulches where the land ultimately becomes suitable for crop production. At other plantations the silty water and mill wastes are flumed to the ocean.

Truck and fruit growers also experience serious soil losses on unprotected land in heavy storms.

The great steepness of cultivated slopes has an important bearing on erosion. Cane is found on Kauai on slopes of 35 to 40 percent, on Hawaii on slopes of 50 to 60 and even 70 percent. Pineapples can be seen on 30 to 40 percent slopes and truck farms in sections of Maui on slopes as steep as 40 percent.

## EROSION POTENTIALS

Slope is not the only criterion, however, for evaluating the adaptability of land for cultivation. When cane was hand harvested, (very little hand harvesting is now practiced), soil losses were slight. On certain steep pineapple lands on Kauai the erosion factor is low. This soil is very stable and has a high moisture intake rate. Pineapple fields that are laid out on the contour and have mulch from the previous crop on the ground are seldom subject to excessive soil losses. Truck crop fields on Maui that are disked (not plowed), have a deep bagasse mulch or an effective cover crop, and that are protected by well-designed interception ditches on the upper side, have little soil loss.

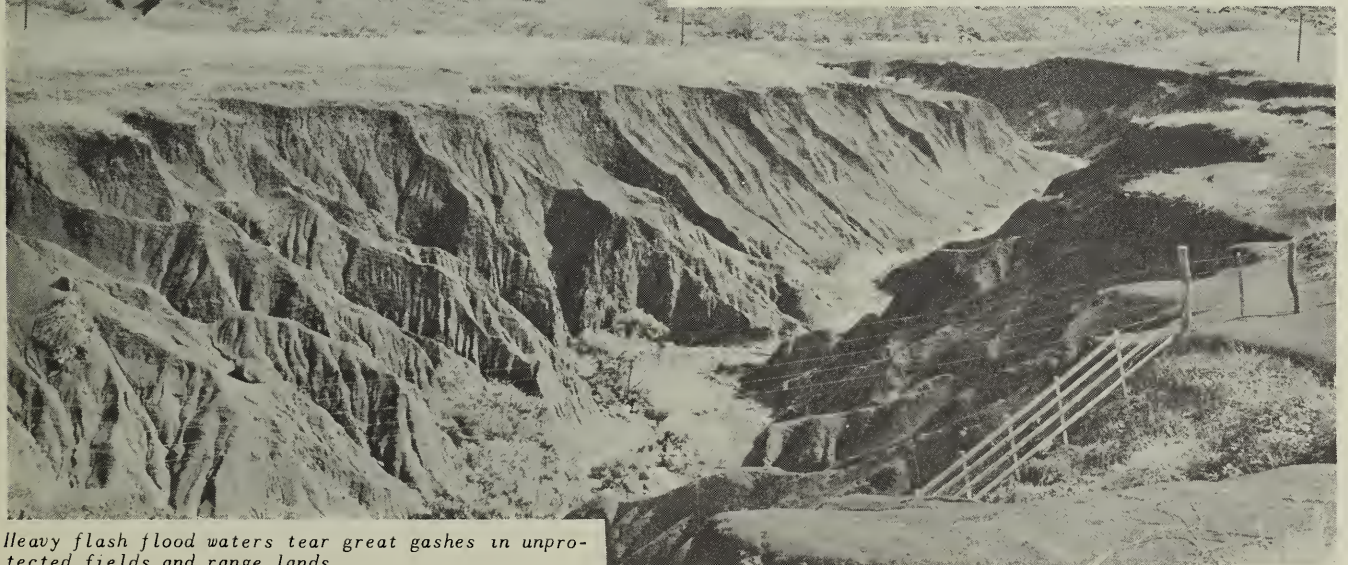
## STEEP LANDS

Unfortunately, these conditions and the cultural practices do not prevail on much of the steep land that is cultivated in the Islands. It is these unprotected lands that produce silt that rings the Islands after a heavy storm, or forms deltas in harbors and bays, or fills the former highly productive fishponds within the reefs, or deposits outwash on the alluvial valley lands.

*Pineapples on the contour with roads and diversion ditches adding erosion control support to the conservation pattern.*



*Heavy flash flood waters tear great gashes in unprotected fields and range lands.*





# Hawaiian Agriculture

## OWNERSHIP AND USE OF LANDS IN 1955 (Area in Acres)

I.	FEDERAL AGENCIES	303,536
	A. U.S. ARMY	27,086
	B. U.S. NAVY	61,696
	C. NATIONAL PARKS	213,969
	D. OTHER	785
II.	PUBLIC LANDS	1,471,471
	A. AGRICULTURAL	38,237
	1. SUGAR CANE	
	LEASES	26,757
	2. PINEAPPLE	
	LEASES	1,752
	3. OTHER	9,728
	B. PASTURE LEASES-ALL	
	CLASSES	398,823
	C. HOMESTEADS	3,331
	D. HOUSELOTS AND BUSINESS	
	PROPERTY	2,947
	E. RESERVATIONS FOR PUBLIC	
	PURPOSES	68,118
	F. FOREST RESERVES	795,245
	G. WASTE LANDS, ROADS AND	
	HIGHWAYS	164,770
III.	PRIVATE LANDS	2,343,193
	A. AGRICULTURAL	303,060
	1. SUGAR CANE	206,987
	A. OWNED BY	
	PLANTATIONS	142,310
	B. LEASED FROM	
	OTHERS	64,677
	2. PINEAPPLE	71,073
	A. OWNED BY	
	PLANTATIONS	26,052
	B. LEASED FROM	
	OTHERS	45,021
	3. OTHER	25,000
	B. PASTURE-ALL CLASSES	659,566
	1. OWNED BY	
	RANCHES	491,886
	2. LEASED FROM	
	OTHERS	167,680
	C. FOREST RESERVES	365,720
	D. CITIES, TOWNS AND WASTE	1,014,847
	GRAND TOTAL	4,118,200

## FARM PRODUCTION

Total amount of produce marketed in the Islands was 139.7 million pounds. The amount of vegetables and fruits by inshipments was 76.2 million pounds in 1956.

Beef and veal consumption was 39 million pounds, of which 57 percent originated in the Islands. Number of beef cattle slaughtered in the Islands was 38,030; dairy cattle, 2,810 head.

Some 17 million pounds of pork was consumed; 59 percent was of Island origin. Hogs slaughtered in the Islands numbered 73,000.

The amount of Island chickens marketed was 3.4 million pounds; this was 48 percent of the total consumed. Of 334.8 cases of eggs sold, 69 percent were of Island origin.

## MILITARY AND TOURIST SPENDING

The military plays a big part in the economy of the Islands. In 1956, the military spent a total of \$284.5 million as follows: purchases and contracts, \$61.9 million; civilian payrolls, \$95.2 million, spending by personnel and families, \$127.4 million.

133,815 tourists spent around \$65 million in the Islands.

## FARMS AND PLANTATIONS

*Some facts from 1950 U.S. Census of Agriculture:*

FARMS, NUMBER	5,750
LAND OWNED BY FARM OPERATORS, ACRES	240,113
LAND RENTED FROM OTHERS BY FARM OPERATORS, ACRES	316,188
LAND MANAGED BY FARM OPERATORS, ACRES	1,980,618
LAND RENTED TO OTHERS BY FARM OPERATORS, ACRES	393
LAND IN FARMS, ACRES	2,432,069
AVERAGE SIZE OF FARMS, ACRES	423.0
VALUE OF LAND & BUILDINGS, DOLLARS	195,277,121
AVERAGE PER FARM, DOLLARS	33,961
AVERAGE PER ACRE, DOLLARS	80.29
CROPLAND HARVESTED, FARMS REPORTING	3,493
CROPLAND HARVESTED, ACRES	159,497



*Harvesting papaya 18 months after planting - one of Hawaii's important income crops.*



Excellent cover crop protecting  
papaya orchard from erosion.



## FARM DISTRIBUTION

RACE OF OPERATOR	NO. FARMS
CAUCASIAN	752
HAWAIIAN OR PART	
HAWAIIAN	478
JAPANESE	3,839
CHINESE	195
FILIPINO	383
KOREAN	65
PUERTO RICAN	32
ALL OTHER	6
TOTAL NO. OF FARMS	5,750

TYPES OF FARMS	NUMBER
VEGETABLE	588
FRUIT (OTHER THAN PINE -	
APPLE AND NUTS)	148
COFFEE	534
SUGARCANE	691
PINEAPPLE	39
DAIRY	55
POULTRY	345
LIVESTOCK (OTHER THAN	
DAIRY AND POULTRY FARMS).	
MOSTLY PIGGERIES AND	
LARGE CATTLE RANCHES	623
GENERAL (NO ONE PRODUCT	
REPRESENTING 50% OF	
VALUE OF ALL PRODUCTS	
SOLD)	227
MISCELLANEOUS AND UN -	
CLASSIFIED (PART TIME,	
RESIDENTIAL, FLOWERS,	
ORNAMENTALS, ETC.)	2,500
TOTAL NO. OF FARMS	5,750

## SIZE OF FARMS

	NUMBER	PERCENTAGE OF NUMBER	ACREAGE	PERCENTAGE OF ACREAGE
ALL FARMS	5,750	100.0	2,432,069	100.0
UNDER 3 ACRES	1,494	26.0	1,898	.1
3 TO 9 ACRES	2,064	35.9	11,286	.5
10 TO 19 ACRES	979	17.1	13,033	.5
20 TO 49 ACRES	690	12.0	20,533	.8
50 TO 99 ACRES	193	3.3	13,061	.5
100 TO 174 ACRES	105	1.8	13,683	.6
175 TO 259 ACRES	41	.7	8,688	.4
OVER 260 ACRES	184	3.2	2,349,887	96.6

## FARM INCOME

In 1956 agricultural income totaled \$304,755,000. In addition, horticultural specialties were estimated at about \$1,500,000.

The breakdown:

SUGAR	\$148,000,000
PINEAPPLE	117,000,000
OTHER CROPS	
COFFEE	\$5,480,000
FRUITS AND	
VEGETABLES	6,492,000
MACADAMIA NUTS,	
TARO, RICE	793,000
TOTAL OTHER CROPS	12,765,000

## Livestock and livestock products

DAIRY, MILK & MEAT	\$9,067,000
BEEF PRODUCTS	7,734,000
HOGS	3,628,000
WOOL & MUTTON	55,000
CHICKENS, EGGS	6,468,000
HONEY, BEESWAX	38,000
TOTAL LIVESTOCK AND	
LIVESTOCK PRODUCTS	26,990,000

## OUR EXPORT BUSINESS

Good advances are being made in exporting some of Hawaii's specialty products. In 1956 they were:

FRESH PAPAYA	1,568,000 LBS.
FRESH PINEAPPLE	11,972,000 "
PAPAYA NECTAR	40,331 CASES
CANNED PAPAYA SLICES	11,426 "
GUAVA NECTAR	13,797 "
PASSION FRUIT NECTAR	881 "
MACADAMIA NUT	10,431 "
PAPAYA JUICE AND PUREE	15,568 GAL.
PASSION FRUIT JUICE AND	
PUREE	77,709 "
GUAVA JUICE AND PUREE	11,026 "
GREEN COFFEE	92,367 BAGS
FLOWER AND FOLIAGE SHIPMENTS	NO RECORDS
	AVAILABLE

## PRODUCTION FACTOR

These and other crops now being tested could be expanded substantially. The limiting factor is not production of the crop per se, but the cost of keeping it within a competitive range, consumer acceptance, overcoming shipping problems, or Mainland quarantine restrictions on the raw or rooted product.



Rice, cotton, sisal, tobacco, and a number of other staple crop plants have been grown successfully in Hawaii. They failed, however, to attain a competitive position because of high production costs.

### PROMISING CROPS

Crops being tested that appear to have promise are: koa haole as a substitute for high protein supplements being imported, litchi, ti, cherimoyas and other fruits of the family Annonaceae, vanilla, sandalwood, lauhala products, taro, bananas, longan, mangosteen, mango, avocado, cacao, citrus, acerola, and pepper.



*A 3-year-old lychee tree hanging heavy with its delicate flavored exotic fruit. Soil protected with cover crop.*



*A heavily laden coffee tree on the famous Kona coast.*



*Thriving passion fruit vines growing on soils erosion proofed by a cover crop.*



*Crew cutting a cane seed crop by hand. Sugar mill and green tree covered West Maui Mountains for a backdrop.*

### LAND OWNERSHIPS

A total of 1,415,684 acres, or 30.4 percent of the land was retained in Territorial ownership in 1956. Responsibility for the administration of the largest amount of this acreage was with the President of the Board of Agriculture and Forestry and the Commissioner of Public Lands. Land under leases and licenses with the latter officer was about 437,000 acres.

Twelve private land owners each having over 30,000 acres control 30.09 percent of the land in Hawaii. The largest of these ownerships is the Trustees, Bernice Pauahi Bishop Estate with 370,171 acres (8.99 percent).

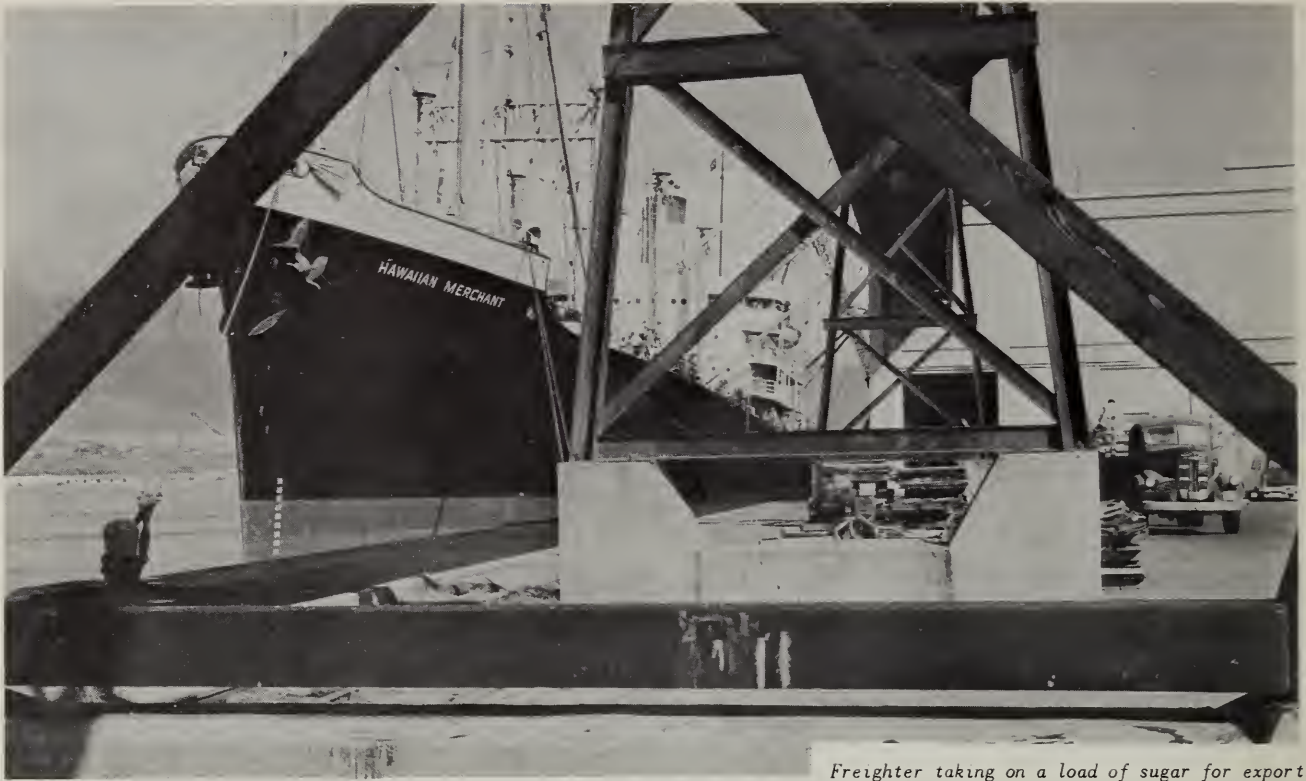


*Bananas from the Island of Oahu--grown on a field well protected from erosion by a heavy litter mulch.*



Income from some of the estates finance various activities. For instance, the Kamehameha Schools are supported by the returns from the Bernice Pauahi Bishop Estate. Boards of trustees that have full control of management functions or those that have strong influence with the heirs can impose contractual and regulatory measures as conditions in the leases. In this way improved management practices can be specified. The conservation advisor of the Bernice Pauahi Bishop Estate recommends a conservation plan of operations for agricultural leases that are being renewed. Others may be guided by recommendations of consultants or by assistance available through the boards of directors of Soil Conservation Districts.





*Freighter taking on a load of sugar for export.*

### TYPES OF LEASES

Just about each kind of land use by a lessor sets up a different set of specifications. Land use may be based on cash or share of crop, amount of improvements to property, or the amount of damage.

Many lessees of small acreages have short tenure. Frequently the lease is on a year-to-year basis and the lessor may be anticipating a change from agricultural use to a subdivision for residential, manufacturing, or business sites. There is little improvement incentive for present users. Of the 5,750 farms in Hawaii, 4,003 farms were on rented land. Of these, 3,295 were farms under 20 acres in size. The 1950 Census reports 316,188 acres of land under lease.

Leases of Territorial land are entirely on a bid basis. The re-lease may or may not go to the present user. Improvements made by the present user in most cases go with the land. His acquired knowledge of management methods may be lost with the succeeding lessees. For strategic areas the bid price may be far out of proportion to the possible returns from the land. Again, long-time objectives in conservation and improvement may be lost to the expediency of crowding the land for its maximum possible return year by year.

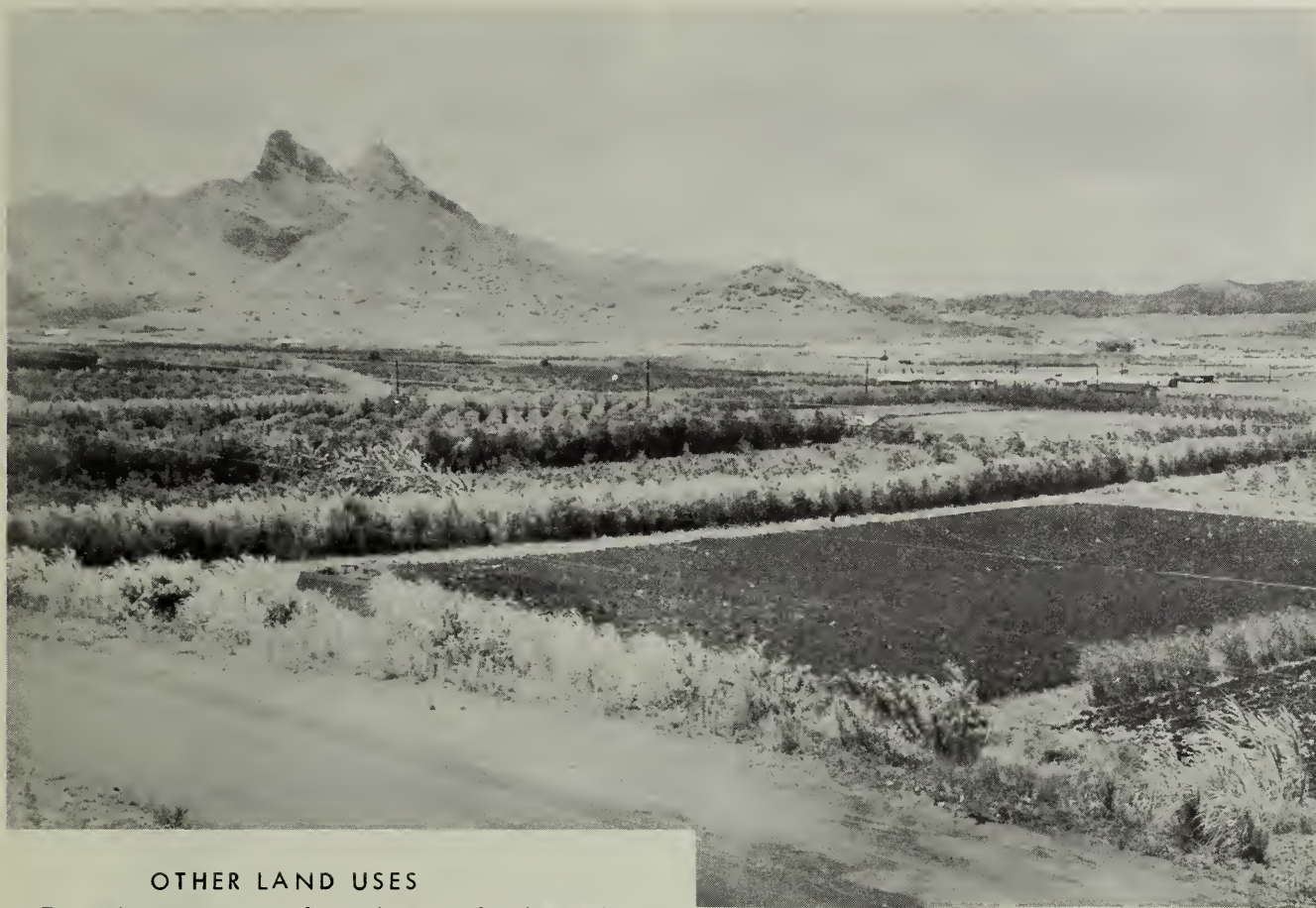


*New grasses, fertilized and managed, are revolutionizing Hawaii's cattle industry. This is pangola grass and big trefoil--Kona SCD.*



*84-year-old Gokichi Yamamoto holding an open poa from his 10-year-old cacao orchard.*





## OTHER LAND USES

Economic pressures and erosion are forcing major changes in land use in Hawaii. For example, since 1930 there has been a gradual shrinkage of sugarcane acreage. Even so, sugar production stepped up. This was due to improved varieties, control of insects, diseases, and weeds, plus better methods of fertilizing and irrigating. These are plantations that have gone out of business in this period:

PLANTATION	YEAR	APPROX. TOTAL	ACREAGE IN CANE	LOCATION	DISPOSITION OF LAND
LOWALU CO.	1932	1,145	645	MAUI	WITH PIONEER MILL
MAKEE SUGAR CO.	1934	9,181	---	KAUAI	WITH LIHUE PLANTATION
WAILEA MILLING CO.	1944	---	1,846	HAWAII	WITH HAKALAU SUGAR CO.
HONOLULU PLANTATION CO.	1946	6,583	5,583	OAHU	NOW OAHU SUGAR & HICKAM FIELD
HONOMU SUGAR CO.	1946	3,602	3,419	HAWAII	WITH PEPEKEO SUGAR CO.
KAELEKU SUGAR CO.	1946	10,000	2,946	MAUI	NOW HANA RANCH
WAIMANALO SUGAR CO.	1946	3,000	2,514	OAHU	NOW 10 ACRE FARMS
WAIANAE SUGAR CO.	1947	5,000	1,235	OAHU	1 RANCH, FARMS OF 1-100 ACRES, HOMESITES AND MILITARY RESERVATION
KOLOA SUGAR CO.	1948	9,960	3,760	KAUAI	WITH GROVE FARM
MAUI AGRI. CO.	1948	9,396	8,600	MAUI	WITH H.C. & S.
WAIKEA MILL CO.	1948	9,000	5,710	HAWAII	40 ACRE FARMS AND HOMESTEADS
KAIWIKI SUGAR CO.	1957	7,369	4,399	HAWAII	WITH LAUPAHOEHOE SUGAR CO.

*Papaya orchards on small farms are an important income crop demanding careful management.*

*Happy people in a high producing potato patch. Farm lands are continuously giving way to urban expansion.*





*The water buffalo was once an important animal in preparing taro fields in Hawaii.*



### SMALL FARMS DEVELOP

Of the 5,750 farms reported in Hawaii in the 1950 Census, some 3,558 are less than 10 acres in size. There were a total of 3,558 enterprises as follows: vegetables, 311; fruit and nuts, 78; coffee, 394; sugarcane, 160; dairy, 16; poultry, 303; livestock other than dairy, 331; general, 137; miscellaneous and unclassified, 1,828.

Production of chickens or hogs under Hawaiian methods require little soil resources. Chickens are kept on runs and in laying batteries and hogs are raised in feed lots.

### FARMING GOES URBAN

Many such farms are in urban areas. They produce nursery stock, flowers, and vegetables. On Oahu the small farmer is gradually being pushed out by urban expansion either to the more remote areas or to the steeper marginal land. It is difficult for a person wishing to farm to either lease or buy land. Land suitable for development is limited and costs of improving it are high. The Territorial government seeks to open public lands to settlement where there is evidence to show that the area is suitable for farming or stock raising.

Most small farms are on Hawaii. There is a heavy concentration of coffee farms at Kona, and a large

number of producers of poultry, vegetables and fruit, and hogs. Next largest concentration is on Oahu which leads in the number of vegetable and hog producers. This island also has a large part of the chicken and fruit producers. Sections at Koko Head, Waimanalo, Waianae, and Pearl Harbor have a large number of small farms. Maui has many producers of poultry, vegetables, and hogs. The Olinda-Kula section on this island is largely small farms. Kauai has the fewest small farms.

Water, as well as good land, is a limiting factor for small farmers. High cost of water and uncertainty of supply are a serious handicap to production.

### MORE POWER NEEDED

A 1950 summary indicated that few farms have power equipment; no tractor, horses or mules, 4,380; no tractor and one horse or mule, 357; no tractor and two or more horses or mules, 333; tractor and horses or mules, 217; tractor and no horses or mules, 463.

Small farms also have the fewest telephones and electricity connections. In 1950 there were 2,017 farms out of 5,750 with telephones; 1,352 out of 3,558 farms under 10 acres had telephones. A total of 3,595 had electricity and 2,580 of them were less than 10 acres.





*Heavy mulch protects the soil in this Chinese squash field in the South Oahu SCD.*



*Bell peppers on the contour. Deep soils on 18% slopes are being held with practices recommended and sponsored by the local SCD's and SCS technicians.*



*High producing pangola pasture has here replaced a poor pasture of guava, yellow foxtail, joe, tar weed and Hilo grass. Herd improvement, fencing and water developments, are changing the Hawaiian livestock industry.*

## LIVESTOCK INDUSTRY

The peak of the livestock population in the Islands was about 1910, although Census data do not indicate this to be true. The 1950 report shows higher figures than in 1910 for all classes of livestock except horses, mules, mule colts, asses and burros, sheep and lambs, and goats and kids. Animals not reported to the Census enumerators made the difference. Those were the feral animals--wild cattle, wild sheep and goats, and wild pigs that

had increased on all the Islands. No estimates are available of the numbers of these animals, but it is known that they were very numerous. Between 1910 and 1950 the numbers of these animals was cut down to keep them proportionate to the areas reserved for them.

Axis deer caused a serious local problem on Molokai. It was introduced in 1867 and reached such numbers by 1898 that professional hunters were brought in to reduce the herds to more reasonable proportions. The hunters killed about 3,500 to 4,000 head a year.





*Modern dairies rush milk to the metropolitan areas daily.*



*Pigs ready for market. Much of the pork consumed in the Islands still come from Mainland USA.*



*Sheep awaiting their turn at the dipping vat.*

## MARKETING PROBLEMS

Practically all the livestock of the independent producer is marketed on consignment. The two largest beef slaughtering companies are on Oahu. The producer delivers his cattle to the meat company. They may be held for a limited period on grass pasture or killed immediately. For its services the meat company acquires the offal of the slaughtered animal in addition to a service charge. The carcass is held in cold storage until it is turned over to a buyer. Then returns are made to the cattle grower.

Beef is delivered to the retailer as quickly as it can be taken up by the trade. When there is a lag in consumer demand or where the retailers are heavily loaded with Mainland shipments, Island beef is retained as carcasses in storage or on the hoof in pastures. When this happens the normal delivery pattern for market-ready livestock is disrupted.

Some of the larger ranches have their own slaughter houses. Here they can kill for local delivery or ship dressed carcasses to the larger Honolulu market. In this case most of the market beef follows the consignment route.

Hogs are marketed somewhat differently than cattle. Separate companies handle slaughtering. There are no storage facilities of consequence at the killing plants and the carcass is sold almost as soon as chilled. If there is a glut in the market hogs may be held in feed yards until the trade can take the pork. Sales are made by the producer or a producer's organization to the wholesaler. Slaughtering is on a charge per head basis. The wholesaler acquires the offal of the carcasses he buys. Distribution is by wholesalers to the retail outlet, not by the slaughtering companies to the retailer as with cattle. Some of the producing groups believe the system used by the cattlemen would improve hog marketing.

## PRODUCTION TRENDS

The number of livestock on farms and ranches and the slaughter of each class in 1956 were as follows:

KIND	NUMBERS ON FARMS AND RANCHES	NUMBER SLAUGHTERED
BEEF CATTLE	156,800	38,030
MATURE DAIRY COWS	12,570	2,810
SHEEP	11,700	1,130
HOGS ALL AGES	71,510	73,000

## IMPROVED METHODS

A little more than half the Island's beef comes from local sources. Until the last decade it was no problem for the Island producer to dispose of his animals. The grass-fed Island cattle was accepted by the consumer. More recently people of Hawaii followed the trend of the Mainland consumer. They responded to the advertising campaign of the meat industry and asked for increasing quantities of well finished feed lot beef. This has caused the Hawaiian cattlemen to study ways of improving their product, thereby putting it on a competitive level with imported meat.

Feed mixtures using high proportions of local by-products are being studied. Combinations of



molasses, pineapple bran, and bagasse with urea show promise in producing higher grades of meat.

Feed lots are now being set up for fattening animals. Feeding is also done under contract.

By harvesting their forage and pen-feeding some of the larger ranchers are getting better use of forage and with less soil compaction from trampling.

### WHAT IS NEEDED

It is evident that a much greater proportion of the Islands' meat requirements could be supplied by local producers. Improvement of pastures by use of high-yielding forage species and fertilizers; development of water for irrigation and livestock use; careful management of pastures; balancing the use of higher and lower lands; better breeding and finishing of livestock; marketing at desirable weights and ages; establishing standards for meat grading and inspection; and provision of adequate storage facilities to level off peaks of production would strengthen the position of Hawaiian cattlemen.

### DAIRY OUTPUT

There were 12,570 head of mature dairy cows in the Islands in 1956. Distribution of dairies by islands was Hawaii, 17; Maui, 5; Molokai, 2; Oahu, 59; and Kauai, 6; a total of 89. Six dairies on Oahu had 300 or more head. There was one other of this size on Maui and another on Hawaii. Some 2,126 head of dairy cattle were imported in 1956.

Average amount of milk produced per cow per day was 10.5 quarts. Total milk marketed from local production was 46,788,000 quarts. Heavy importations of butter, butterfat, cheese and canned and dried milk are made to supply consumer's needs.

As Honolulu's metropolitan area continues to expand, some of the larger dairies are moving their operations. Some dairy leaders predict that in time the bulk of Oahu's domestic milk supply will come from other islands.

### SHEEP AND PIGS

The four commercial sheep operations listed in 1956 showed a total of 11,700 head. All told, the 1900 Census reported 102,098 head on 27 farms and ranches.

In 1956 there were 358 commercial swine producers with 57,040 head above the weaning age and 14,470 suckling pigs. The 1900 Census listed 8,057 head.

### SUGAR CANE AND PINEAPPLES

The agricultural economy of the Islands hinges on sugar and pineapples - the prime users of labor, materials and shipping. They provide the trade balance between exports and imports. Both are subject to stiff competition, sugar from sugar beet producers on the Mainland and pineapples from all other canned fruit and juice products.

### SUGAR CANE FIRST

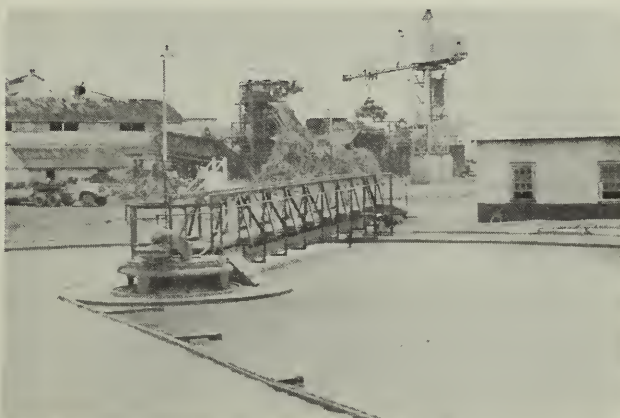
Sugarcane occupies 70.4 percent of the cultivated land and pineapples 24.6 percent. Combined



*When harvesting sugar cane, it is pushed into windrows, power loaded on trucks and whisked off to the mill.*



*This newly planted cane field without erosion control practices lost tremendous quantities of soil following a heavy rain.*



*The McBryde Sugar Company uses a hydro-separator to reclaim the silt from the mill's wash water and return it to the fields.*

total acreage of land used for these two crops is 95 percent of Hawaii's cultivated acres. The area producing vegetables, fruit, nuts, coffee, and other produce is 5 percent of cultivated land. Returns from the sugar cane acreage was 148 million dollars in 1956 and from the pineapple acreage the same year, 117 million dollars. With such a large part of cultivated land in sugarcane and pineapples, plantation operations have a major influence on soil and water conservation. The extent to which the different plantations apply effective erosion-control practices depends on a number of things.

### PLANNING NEEDED

A first responsibility of any plantation manager is to plan and carry out a production schedule that will show a favorable financial balance at the end of a given period. In this, plantations function as any other corporation. Changes in operating procedures are introduced gradually, and usually after a considerable period of investigation.

Machinery, more often than not, is custom-built to meet specific operational needs.

*Diversion ditch will carry runoff water from cane fields.*

### EFFICIENCY PAYS OFF

Plantations intend to stay in business. The plantation management realizes that improved production and greater efficiency cannot be expected on a deteriorating soil or diminishing water supply.

Many plantations operate wholly or in part on leased land. Owners or trustees of these lands also recognize that careless or indifferent systems of culture will ultimately reduce revenue. Clauses are included in many of the leases specifying erosion control measures.

### SUGAR CANE PRODUCTION

Hawaii's sugar production is the highest in the world. In 1956 average production was 5.14 tons of raw sugar per acre on a 12-month basis. The highest 12-month record for yield per acre was 1955 with 5.37 tons. A record crop was made in 1955 by the Olokele Sugar Company of Kauai. It manufactured 7.76 tons of raw sugar per acre on a 12-month basis. By comparison, averages for 1954 for Hawaii and other sugar producing sections were Hawaii, 5.01 tons; Australia, 3.7 tons; Florida, 3.43 tons; Puerto Rico, 3.28 tons; Philippines, 2.0 tons; Cuba, 2.0 tons; and Louisiana, 1.94 tons per acre.



*High powered heavy harvesting and loading equipment is fast replacing former hand harvesting methods.*



Sugar production quotas apply to both preferred nations and domestic producers. Hawaii produces about 1,100,000 tons of sugar. This is almost one-fourth of all the sugar produced in the United States, and about 3 percent of world sugar production.

## PLANTATION OPERATIONS

Since 1946 revolutionary changes have been made in plantation operations. Prior to 1946 labor was plentiful, relatively cheap, and cane was harvested by hand. Cane tops and other residues were left on the land and provided an effective mulch for open fields.

## CHANGING TECHNIQUES

As plantation labor came under union organization, field operations were rapidly mechanized to offset increasing labor costs. Bulldozers with shear blades were used to cut and windrow the cane after it had been defoliated by burning. Cranes with double-jawed cane grabs were used for loading the cut cane. Field railroad systems have almost entirely given way to trucks for hauling the cane to the mills. Soil-protective features of the hand-harvested cane were largely lost.

These changes created complex soil-management problems which did not exist under the old system. Heavy trucks and machinery compact the soil which seriously affects moisture penetration and water storage.

The former effectiveness of the ratoon crop in controlling erosion is lessened under the new system. Cutting with machines frequently leaves only a partial stand of cane and requires replanting of uprooted areas.

## SOIL LOSSES

Large quantities of soil are hauled with cane to mills. Wash water carrying soil and trash may be run into the ocean, into settling basins to develop new cane lands, or through hydroseparators. In the latter case, clarified water can be re-used in the mill or returned to the irrigation system and soil can be returned to fields.

Soil losses are greatest on non-irrigated plantations. These are in higher rainfall belts and usually slopes are considerably steeper. High-intensity storms cause tragic soil losses on open fields. Where the cane canopy is closed, there is little soil movement except on field roadways.

## IRRIGATION METHODS

Hawaiian cane in the past was usually irrigated by the "closed" system. Ditches made a herring-bone pattern with "feeder" or head ditches on two sides of the field. There were no pick-up ditches. Recently tests are being conducted on use of portable sprinklers, too.

Although the system of growing cane under irrigation offers protective features, torrential rains even of short duration can break the ditch systems and cause severe washing. A peak period in the storm of November 28, 1954, caused a severe breakage of furrows on an Oahu plantation. The intensity reached 3.5 inches per hour. A contributing factor to the furrow failure was an earlier prolonged, rainy period which saturated the soil.

Within the last few years "long line" systems are being installed using aluminum flumes. This is an adaptation of the conventional furrow system. It provides for increasing the head of water at intervals on the feeder lines.

## SUGAR ACT OF 1937

To maintain the position of United States producers, the Sugar Act of 1937 provided for financial reimbursement to domestic producers. In 1955 this returned \$10,179,145.96 to Hawaiian planters, or \$10 a ton of sugar marketed. But even with Federal assistance by tariffs, quotas, and financial aid, the industry as a whole and a number of plantations in particular operate on narrow margins. Not included in the total earnings are the returns from the sale of molasses and other subsidiary crops or activities of the plantations.

The following table shows some of the variations in production between plantations. In 1956 average price of sugar on the New York market was \$121.76 per ton.

## SUGAR PRODUCTION - SELECTED PLANTATIONS - 1956

*Data from Manual of Hawaiian Securities, Statements of 1956*

	AVE. TONS CANE PER ACRE	AVE. TONS SUGAR PER ACRE	AVE. TONS CANE PER TON SUGAR	PRODUCTION COST PER TON SUGAR AT MARKET
EWA PLANTATION CO.	108.25	13.37	8.10	\$115.47
HAWAIIAN AGR. CO.	121.39	11.17	10.86	113.40
HAWAIIAN COMMERCIAL & SUGAR CO.	99.08	12.97	7.64	108.34
HONOKAA SUGAR CO.	66.0	6.17	10.70	129.03
KAHUKU PLANTATION CO.	94.9	10.06	9.43	134.59
KEKAHA SUGAR CO.	91.1	12.75	7.14	111.63
THE LIHUE PLANTATION CO.	74.8	8.13	9.20	130.65
MCBRYDE SUGAR CO.	84.9	11.15	7.62	124.87
OAHU SUGAR CO.	101.5	13.18	7.70	128.93
OLAA SUGAR CO.	89.9	7.73	11.63	---
ONOMEA SUGAR CO.	96.2	8.82	10.90	123.92
PEPEEKEO SUGAR CO.	102.8	9.66	10.64	111.11
PIONEER MILL CO.	104.6	12.55	8.33	111.98
WAIALUA AGRICULTURAL CO.	104.4	12.99	8.04	115.27
WAILUKU SUGAR CO.	101.74	12.01	8.48	127.54



*Hand cutting cane is a thing of the past.  
After cutting it was flumed to the mill.*

# HAWAIIAN SUGAR PLANTATIONS -- 1956

## Agents and Extent of Operations

<b>KAUAI</b>	
KEKAHA SUGAR Co. AMERICAN FACTORS, LTD.	LEASES 28,458 ACRES; 7,252 ACRES IN CANE; OWNS 135 ACRES, 10 ACRES IN CANE; HERD OF BEEF CATTLE, 971 HEAD
WAIMEA SUGAR MILL Co. AMERICAN FACTORS, LTD.	OWNS NO LAND; LEASES 1,189 ACRES; 621 ACRES IN CANE; DAIRY OF 409 HEAD; BEEF CATTLE 63 HEAD
GAY & ROBINSON BISHOP TRUST Co., LTD.	
OLOKELE SUGAR Co., LTD. C. BREWER & Co., LTD.	OWNS NO LAND; LEASES 5,405 ACRES; TOTAL IN CANE 4,587 ACRES
McBRYDE SUGAR Co., LTD. ALEXANDER & BALDWIN, LTD.	OWNS 22,190 ACRES; 5,280 IN CANE; LEASES 49 ACRES
GROVE FARM Co., LTD. PERFORMS OWN FUNCTIONS	OWNS 22,641 ACRES, LEASES 3,182 ACRES, TOTAL 25,823 ACRES; 8,630 ACRES IN CANE; 894 ACRES IN PINEAPPLE; HAS BEEF HERD OF 913 HEAD
THE LIHUE PLANTATION Co., LTD. AMERICAN FACTORS, LTD.	OWNS 43,236 ACRES, LEASES 12,134 ACRES, TOTAL 55,370 ACRES; 14,009 ACRES IN CANE; BEEF HERD OF 2,131 HEAD
KILAUEA SUGAR PLANTATION Co. C. BREWER & Co., LTD.	OWNS 9,266 ACRES, LEASES 4,049 ACRES, TOTAL 13,315 ACRES; 4,389 ACRES IN CANE
<b>OAHU</b>	
WAIALUA AGRICULTURAL Co., LTD. CASTLE & COOKE, LTD.	LEASES 29,200 ACRES; 9,800 ACRES IN CANE
KAHUKU PLANTATION Co. ALEXANDER & BALDWIN, LTD.	OWNS 29 ACRES, LEASES 6,883 ACRES; 3,715 ACRES IN CANE
OAHU SUGAR Co. AMERICAN FACTORS, LTD.	OWNS 1,644 ACRES, LEASES 29,562 ACRES, TOTAL 31,206 ACRES; 10,804 ACRES IN CANE; BEEF HERD OF 276 HEAD
EWA PLANTATION Co. CASTLE & COOKE, LTD.	OWNS NO LAND, LEASES 11,369 ACRES; 8,690 ACRES IN CANE
<b>MAUI</b>	
PIONEER MILL Co., LTD. AMERICAN FACTORS, LTD.	OWNS 15,280 ACRES, LEASES 9,105 ACRES, TOTAL 24,385 ACRES; 9,501 ACRES IN CANE; BEEF HERD OF 1,704 HEAD
WAILUKU SUGAR Co. C. BREWER & Co., LTD.	OWNS 26,383 ACRES, LEASES 344 ACRES, TOTAL 26,727 ACRES; 4,787 ACRES IN CANE; DAIRY OF 790 HEAD
HAWAIIAN COMMERCIAL & SUGAR Co., LTD. ALEXANDER & BALDWIN, LTD.	OWNS 53,834 ACRES, LEASES 2,067 ACRES, 26,811 ACRES IN CANE; OPERATES GROVE RANCH, BEEF HERD OF 1,679 HEAD
<b>HAWAII</b>	
KOHALA SUGAR Co. CASTLE & COOKE, LTD.	OWNS 20,576 ACRES, LEASES 4,265 ACRES, TOTAL 24,841 ACRES; 12,857 ACRES IN CANE; INDEPENDENT PLANTERS ACREAGE 751 ADDITIONAL
HONOKAA SUGAR Co. THEO. H. DAVIES & Co., LTD.	OWNS 13,588 ACRES, LEASES 3,466 ACRES, TOTAL 17,050 ACRES; 7,781 ACRES IN CANE; 470 ACRES IN MACADAMIA NUTS
PAAUHAU SUGAR Co. C. BREWER & Co., LTD.	OWNS 3,563 ACRES, LEASES 1,460 ACRES, TOTAL 5,023 ACRES; 4,118 ACRES IN CANE; GROWERS CANE 938 ACRES
HAMAKUA MILL Co. THEO. H. DAVIES & Co., LTD.	OWNS 14,423 ACRES, LEASES 7,666 ACRES, TOTAL 22,089 ACRES; 7,031 ACRES IN CANE
KAIWIKI SUGAR Co., LTD. THEO. H. DAVIES & Co., LTD.	OWNS 2,202 ACRES, LEASES 5,105 ACRES, TOTAL 7,369 ACRES; 4,399 ACRES IN CANE

THE OPERATIONS OF KAIWIKI SUGAR Co., LTD., WERE ABSORBED  
BY LAPAHOEHOE SUGAR Co., JANUARY 1, 1957.



LAUPAHOEHOE SUGAR Co. THEO. H. DAVIES & Co., LTD.	OWNS 5,894 ACRES, LEASES 1,489 ACRES, TOTAL 7,083 ACRES; 3,467 ACRES IN CANE; INDEPENDENT GROWERS AND COOPERATING PRODUCERS 2,427 ACRES ADDITIONAL IN CANE
HAKALAU PLANTATION Co. C. BREWER & Co., LTD.	OWNS 19,510 ACRES, LEASES 2,270 ACRES, TOTAL 22,810 ACRES; IN CANE 5,886 ACRES; CANE LANDS OWNED BY GROWERS OR LEASED FROM OTHER GROWERS 1,614 ACRES ADDITIONAL
PEPEEKEO SUGAR Co. C. BREWER & Co., LTD.	OWNS 10,684 ACRES, LEASES 1,390 ACRES, TOTAL 12,074 ACRES; 5,763 ACRES IN CANE; GROWERS CANE 675 ACRES
ONOMEA SUGAR Co. C. BREWER & Co., LTD.	OWNS 26,630 ACRES, LEASES 1,626 ACRES, TOTAL 29,255 ACRES; 6,223 ACRES IN CANE; GROWERS CANE 653 ACRES
HILO SUGAR Co. C. BREWER & Co., LTD.	OWNS 15,535 ACRES, LEASES 2,943 ACRES, TOTAL 18,478 ACRES; TOTAL IN CANE 6,549 ACRES; INDEPENDENT GROWERS OWN OR LEASE FROM OTHERS 276 ACRES ADDITIONAL
OLAA SUGAR Co., LTD. AMERICAN FACTORS, LTD.	OWNS 24,558 ACRES, LEASES 7,878 ACRES, TOTAL 32,436 ACRES; 9,313 ACRES IN CANE; LEASES TO INDEPENDENT GROWERS 2,764 ACRES
HAWAIIAN AGRICULTURAL Co. C. BREWER & Co., LTD.	OWNS 15,460 ACRES, LEASES 58,817 ACRES, TOTAL 74,277 ACRES; 8,607 ACRES IN CANE; OPERATES THE KAPAPALA RANCH WITH 5,579 HEAD OF CATTLE; GROWERS CANE 738 ACRES
HUTCHINSON SUGAR Co. C. BREWER & Co., LTD.	OWNS 24,389 ACRES, LEASES 34,043 ACRES, TOTAL 58,432 ACRES; IN CANE 5,006 ACRES; OPERATES BEEF HERD OF 5,882 HEAD; CANE LAND OWNED BY GROWERS OF OTHERS 200 ACRES ADDITIONAL

Agents are commonly known as factors. These firms handle much of the financial, shipping, merchandising, and experimental needs of the plantations. Until late in 1956 all sugar plantations in Hawaii have been assisted or managed by agents. In September of that year Grove Farm Co., Ltd., removed itself from agent management and established its own administrative, technical and management staff.

## PINEAPPLE PRODUCTION

The pineapple pack in 1955-56 of 18,464,061 cases of fruit was the largest on record. The pack of pineapple juice was highest in 1954-55 with 13,011,268 cases. Fresh frozen chunks and fresh frozen juice concentrate are also on the market.

Hawaii, in crop year 1955-56, produced 74.2 percent of the world's canned pineapple products. Here, most of the pineapple companies are both growers and packers. Estimates of market demand are forecast several years in advance of planting a new crop.

Pineapple products enter into a highly competitive market. In 1956 the pack of pineapples was 18.5 million cases. Canned fruits of all kinds in the United States was 128.6 million cases. The juice pack for the same year was 12.1 million cases out of a total U. S. pack of 119.7 million cases. There has been a slight falling off percentage-wise of pineapples in the canned fruit trade; and pineapple juice lines have not maintained the percentage increases shown by such competitive leaders as frozen orange concentrate and tomato juice.

## OPERATIONS

The change to labor-saving equipment came about on pineapple plantations at the same time as on

sugarcane lands. Pineapples usually occupy land where the water supply is not adequate for the production of cane, although on one plantation cane and pineapples are being grown in a rotation system. Pineapple culture has come through several stages. Formerly little attention was given to field layout and rows and roadways ran up and down hill. Wash from fields was so heavy that there was considerable abandonment of the upper steeper slopes.



*The pineapple industry is highly mechanized. Spraying with iron sulphate--one of the earliest minor element deficiencies to be recognized.*

*Pineapples planted across the slope is the new order in most plantations today.*



### EROSION

As awareness of erosion increased, operators turned to field systems that offered better possibilities of control. Several plantations designed and installed effective terrace systems on all their land. Others terraced only more critical areas. At any rate, extensive progress was being made in adopting erosion-control systems when the labor situation became acute.



*Severe erosion can follow when recently cleared pineapple fields are left open to heavy rains.*

### MECHANIZATION

With mechanization, layout of fields was generally redesigned to conform to the lay of the land. Fields are rather uniformly 100-130 feet wide, permitting use of equipment having 50-65 foot booms attached to one or both sides of a truck or tractor. Spraying for insects and plant diseases, fertilizing, irrigating, and harvesting are done with various adaptations of boom equipment. Although terrace systems do not conform to redesigned field layouts, they are generally being maintained.

### MULCHING & RESIDUES

Mulching equipment has been designed and is being improved to keep pineapple stumps on the surface. Formerly these residues were plowed under or



*Many rows of pineapples being harvested at the same time--the fruit is selected, placed on power boom and deposited in a bin on the truck.*



*Cucumbers planted on a grass mulch and furrow irrigated field. Little or no erosion can be found on this steep East Kauai SCD field.*



*Trees and brush being removed preparatory to pasture and range seedbed preparation and planting.*



burned. Repeated diskings and natural disintegration gradually reduced the material until the fields could be replanted in 9 months or a year. Thus, two crops could be grown in 4 years. Now it is possible, through the use of residues as a surface mulch, to obtain two harvests in 3 years.

The practice is not entirely satisfactory in all respects, however. At higher elevations the sweetness of the fruit is reduced and ripening is delayed when a mulch is used. Also, in higher rainfall areas root rot is a constant threat on either mulched or unmulched fields.

Burning to reduce residues is often used to reduce the time between harvests. Only finer parts of the plant are destroyed; heavier parts then are turned under.

In pineapple fields a plant residue mulch covers only half of field area. Propagating pieces are planted through a layer of tarred or asphaltic paper. The mulch between effectively takes up runoff from the covered strips.

### DISTRICT RELATIONS

All phases of agricultural production are included in soil conservation district work. The managers of sugar and pineapple plantations work seriously to conserve soil and water resources. Large and small ranchers are active in district work and so are truck, fruit, coffee and specialty producers. Members of the boards of directors of the districts are representative of all these categories of agricultural economy.



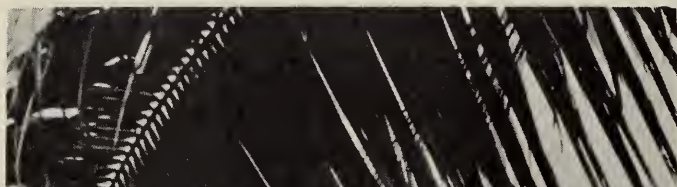
*Soil Conservation District Directors gathered for a regular monthly meeting. Cooperators and technicians meet with them.*



Programs and work plans are developed in each district to analyze conditions and to work out procedures of operation. These are reconsidered at intervals to adjust activities in line with experience or changing conditions.

A further important field of interest is from Territorial, city and county agencies. They too have a keen interest in protecting and improving the land under their jurisdiction. They participate as any other land owner or operator in district work. Still other participating groups are the military agencies. Plans for the protection of the defense installations are prepared and the accomplishments in practice application are included in the progress reports of districts.

*Canning pineapples--an important user of local labor.*



*A pineapple cannery, the largest of its kind, is located in Honolulu to process Island pineapples.*

## HAWAIIAN PINEAPPLE COMPANIES

COMPANY	CANNERY	PLANTATION
BALDWIN PACKERS, LTD.	LAHAINA, MAUI	HONOLUA, MAUI
CALIFORNIA PACKING CORP.	HONOLULU, OAHU	WAHIAWA, OAHU KUALAPUU, MOLOKAI
GROVE FARM, LTD.	PUHI, KAUAI	PUHI, KAUAI
HAWAIIAN CANNERIES CO., LTD.	KAPAA, KAUAI	KAPAA, KAUAI
HAWAIIAN FRUIT PACKERS, LTD.	KAPAA, KAUAI	KAPAA, KAUAI
HAWAIIAN PINEAPPLE CO., LTD.	HONOLULU, OAHU	WAHIAWA, OAHU LANAI CITY, LANAI
KAUAI PINEAPPLE CO., LTD.	LAWAI, KAUAI	LAWAI, KAUAI
LIBBY, MCNEIL & LIBBY	HONOLULU, OAHU	WAIPIO, OAHU
	PAUWELA, MAUI	HAIKU, MAUI MAUNALOA, MOLOKAI
MAUI PINEAPPLE CO.	KAHULUI, MAUI	HALIIMAIL, MAUI



# Conservation Operations and Programs

Field of pineapples with its owner and his Soil Conservation District roadside sign.



## SOIL CONSERVATION DISTRICTS

Organization of Soil Conservation Districts in Hawaii is virtually completed. Sixteen districts have been organized since enactment of authorizing legislation in 1947. The first was Olinda-Kula on Maui which had a favorable referendum in January 1948. The most recent was Central Maui on Hawaii which was voted in on May 19, 1957.

These districts include 3,369,754 acres comprising 4,968 farms. Land not yet in districts includes: Lanai with 90,200; Niihau with 46,000 acres; Kahoolawe with 29,000 acres; and a few plantations and ranches scattered through the other islands. Municipalities also take up a portion of the remaining area.



## HAWAII SCD'S

DISTRICT NUMBER	NAME	CERTIFICATE OF ORGANIZATION ISSUED	ACRES	ACRES IN FARMS	NUMBER OF FARMS
1	OLINDA KULA	4-2-48	15,219	15,219	266
2	WAIMANALO	6-7-48	5,043	3,400	110
3	MOLOKAI	8-19-48	166,400	152,300	218
4	WAIKEA	9-6-49	9,560	6,410	120
5	WEST OAHU	1-4-50	148,600	58,500	390
6	KOOLAU	3-4-50	71,500	41,300	380
7	PUNA	10-3-50	325,000	240,833	416
8	KAU	10-3-50	633,000	497,824	65
9	SOUTH OAHU	11-19-52	59,000	6,000	600
10	KONA	6-18-53	513,088	477,124	800
11	EAST KAUAI	6-26-53	123,000	101,145	178
12	WEST KAUAI	6-26-53	137,000	59,807	120
13	HANA	9-9-53	38,750	20,038	50
14	WEST MAUI	11-15-54	57,026	7,500	149
15	MAUNA KEA	5-16-55	934,000	538,670	1,096
16	CENTRAL MAUI	6-6-57	103,568 +	103,489 +	10
TOTAL			3,369,754	2,329,559	4,968



Boy and girl participants in a Maui land judging contest.



*Cooperation is the keyword at East Kauai SCD--Interagency meeting with representatives of ASC, AES, SCS and FHA.*



### DISTRICT LEADERS

Soil Conservation District directors are both elected and appointed. Three of the five board members are elected at the time of the district referendum. Two are subsequently appointed by the Hawaii Soil Conservation Committee. Replacements of directors are in the manner of their original selection. Six Districts--Molokai, Olinda-Kula, Mana, West Maui, Kau and Mauna Kea--have set up appointment of assistant directors to advise and work with directors in developing and carrying out district's activities. Association meetings have been held biennially. The expenses of delegates at the meetings have been met from Territorial appropriation to the Hawaii Soil Conservation Committee. Provision is made similarly for meetings of the Executive Committee of the Association. This committee consists of a Vice President elected from the district (s) of each island plus the President and Secretary of the Territorial association.



*A Soil Conservation District cooperators' wife explains the benefits of mulching to a tour group.*

### WATERSHED PROJECTS

Watershed protection work as provided by Congress in 1956 is applicable to Hawaii. In this, Federal assistance is provided for projects that include municipal and industrial water-supply development, as well as those involving upstream flood prevention, irrigation and other phases of agricultural water management. Although most of the streams in Hawaii are short and drop their loads almost directly into the ocean, serious damages occur from high intensity storms. Studies are being made to appraise flood and land damage and to evaluate possible flood control measures.

### GROUP ENTERPRISES

Group action by farmers to construct irrigation, drainage, or erosion control facilities has not progressed to the operations stage. There are a number of situations, however, where joint activity would be desirable. Preliminary information has been assembled for a few locations where landowners or group leaders indicated an interest.

### THE WORK OF THE SOIL CONSERVATION SERVICE

The Soil Conservation Service is the technical soil and water conservation agency of the U. S. Department of Agriculture. It is responsible for developing and carrying out a national program of land and water resource conservation.

It administers Department of Agriculture activities involving technical assistance in soil and water conservation and flood prevention on private land. It gives technical information and services needed by other agencies in related programs.

Objectives of the national soil and water conservation program is to achieve land use adjustments and treatment that will conserve land and water resources, establish a more permanent and stable agriculture, reduce the hazards of flood and sedimentation, and assure the most productive long-term use of soil and water.



*A restful scene in a country noted for its beauty and peace*



### ADMINISTRATION OF THE SCS

The work of the Soil Conservation Service is directed by the Administrator and his staff from the central office in Washington, D. C. The Territorial Conservationist is responsible for field operations and for relations with Federal and Territorial agencies and organizations in Hawaii.

Work Unit Conservationists located with their staffs at Lihue, Kailua, Kaunakakai, Kahului, Hilo, Naalehu, Kealahue and Honokaa provide for Service cooperation with the 16 soil conservation districts of Hawaii. Technical and administrative specialists are located with the Territorial Conservationist at Honolulu and strategically on the Mainland to provide scientific and technical guidance and training to field personnel and to produce land capability maps and other essential working materials.

### SOIL AND WATER CONSERVATION OPERATIONS

The Soil Conservation Service, under national laws, carries on a broad program of soil and water conservation operations including direct assistance to farmers and ranchers and technical services to other agencies and organizations.

The primary job of the Service is helping farmers and ranchers, individually or in groups, do conservation work on the land. SCS provides this assistance mainly through locally organized soil conservation districts. Related activities include conducting soil surveys and soils research; helping find and improve plant materials for conservation uses; providing technical services with other Departmental programs involving financial or other assistance in conservation work; consulting with the Agricultural Research Service and State Experiment Stations on needed soil and water conservation research; assisting the Extension Service and other educational agencies, institutions, and organizations doing soil and water conservation education; and providing technical services and information to state and federal agencies having land administration responsibilities.



*A typical early morning scene in the coffee producing area at Kona.*

### AID TO SOIL CONSERVATION DISTRICTS

The Soil Conservation Service assists the more than 2,700 soil conservation districts and their cooperating farmers and ranchers plan and apply locally adapted conservation programs.

The affairs of each district are directed by an unsalaried local board chosen by the people of the district. In Hawaii as elsewhere, these districts are legal subdivisions of Territorial government. District activities are coordinated by the Hawaii Soil Conservation Committee consisting of a chairman and four members. The SCS helps the local boards analyze their conservation problems and formulate locally adapted programs and plans of action to meet them. Each district prepares a written program of work which serves as a basis for the Department of Agriculture and the Soil Conservation Service to enter into formal agreements to furnish technical assistance.

After these agreements are reached, SCS technicians assist farmers and ranchers directly on the ground to do conservation work on their land in accordance with the district program. This assistance involves four principal steps:



*Drying Kona coffee, the kind highly prized for blending with less distinctive types.*



First, a soil scientist makes a detailed, acre-by-acre soil survey of the farm, plantation or ranch. SCS gives the operator a soil and land-capability map of his land.

Second, the conservationist gives the farmer or rancher information about the treatment and use of his land within its capability, as indicated by the survey. The operator decides upon a conservation plan that includes combinations of practices needed to control erosion, preserve and improve the productivity of soils, conserve water, and use the soil and water resources for efficient and productive farming or ranching.

Third, SCS technicians help the operator apply the parts of the plan that require special skills or knowledge. These include such things as engineering design and layout for construction jobs and guidance in planting and managing pastures, ranges, woodlands and wildlife areas.

Finally, the technicians give the guidance needed for maintaining and improving the farm or ranch conservation plan after it is applied to the land.

To provide these services, the SCS brings together in one national staff the scientists and technicians needed to solve practical problems of land use and conservation. Its soil conservationists are skilled in coordinating and applying to a particular land area (a farm, ranch, or watershed) the knowledge necessary to conserve soil and water and related resources.

### SOIL SURVEY

As an integral part of its national program, the Soil Conservation Service carries out the Federal part of the National Cooperative Soil Survey. Soil surveys meet the immediate needs of the soil and water conservation program. They also meet other needs for detailed information about soils and rural land classification. Survey reports are published by the Department.

Soil surveys provide information for land capability classification as a basis for conservation

planning in soil conservation districts. A cooperating farmer or rancher uses the land-capability map of his land as a guide for developing his individual plan.

Soil survey work includes basic and applied research in soils. Research is essential to the correct classification of soils, to the interpretation of the survey information, and to the development of principles and techniques of soil management and conservation.

The SCS cooperates with the Hawaii Agricultural Experiment Station on both the basic and applied research in soils.

### IMPROVEMENT OF PLANT MATERIALS

The Soil Conservation Service helps to assemble, screen, and increase plant materials that have possible value in soil and water conservation. This work in Hawaii is centralized at Kahului, Maui. The studies are carried out cooperatively with the Agricultural Experiment Station and the Extension Service of the University of Hawaii to avoid overlapping of work and to arrange for free exchange of information.

Potentially valuable plant materials are evaluated in the field to determine their soil and climatic adaptation, growth and seed habits, and their conservation values. Supplies of select materials are increased by farmer producers for use in Hawaii; heretofore seed supplies from foreign or domestic sources have been irregular in both quantity and quality.

### AGRICULTURAL CONSERVATION PROGRAM

The Soil Conservation Service provides technical assistance to the Agricultural Conservation Program Service and to farmers and ranchers in the Department's program of cost-sharing for conservation practices of public benefit. This service includes providing technically adequate designs and specifications for permanent-type practices in the pro-



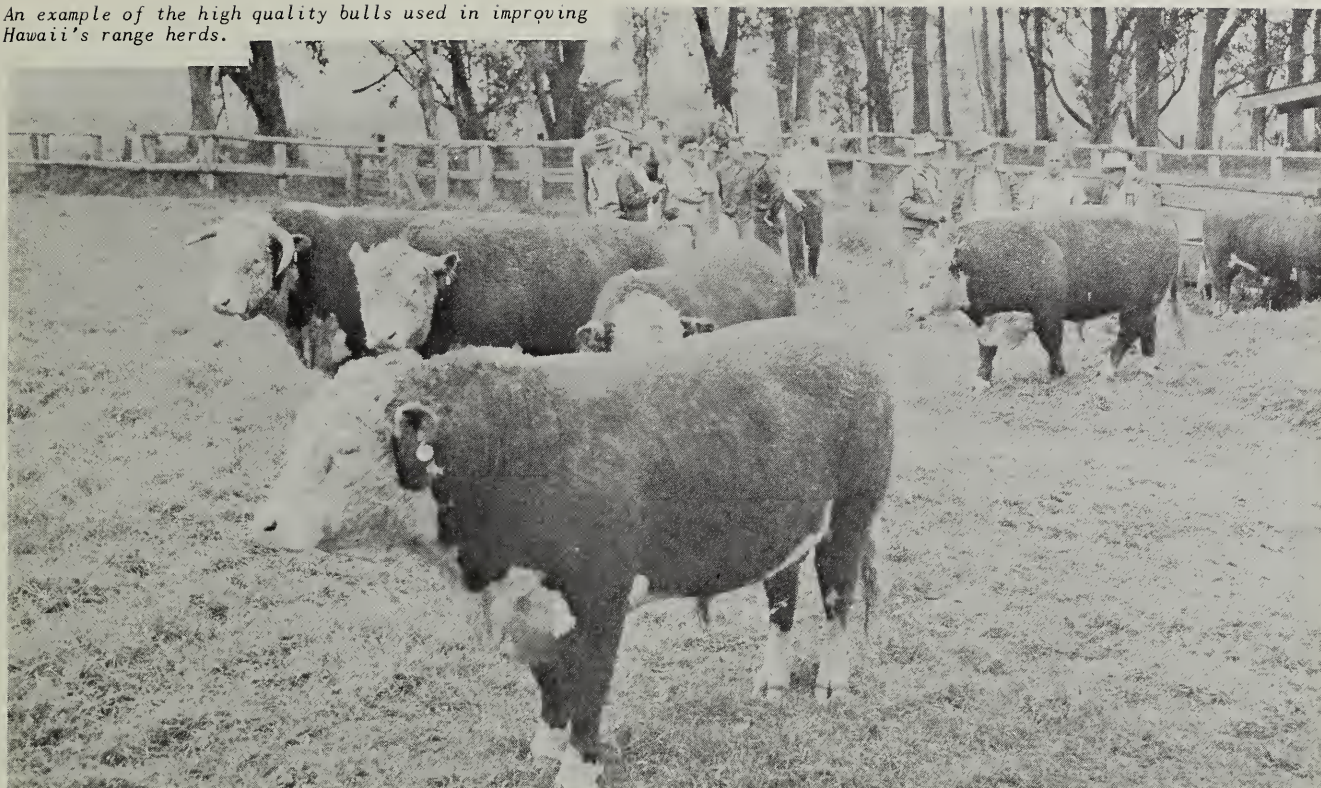
*Fertilizer pasture test plots are helping determine pasture and range improvement programs.*



*Trial plots are visited regularly by ranch cooperators and SCS technicians.*



*An example of the high quality bulls used in improving Hawaii's range herds.*



gram. For each job undertaken, SCS technicians determine need and feasibility, provide designs and layout, supervise installation, and check and certify compliance to technical standards.

The SCS is represented at the Territorial and Island level as members of advisory committees helping in the formulation of the Agricultural Conservation Program. Soil conservation district directors are likewise consulted. This provides an opportunity for coordinating Departmental programs with the objectives and activities of the local districts.

### CONSERVATION LOANS

The Soil Conservation Service provides technical assistance to the Farmers' Home Administration in making soil and water conservation loans to farmers and ranchers. These loans are authorized to give adequate financing for soil conservation, water development, water conservation and use, forestation, drainage, establishing and improving permanent pasture, and related measures.

SCS cooperates with FHA by reviewing the technical phases of loan applications that concern soil information, engineering design and layout, and other soil and water conservation problems. SCS upon request assists loan applicants in preparing plans and designs and supervises the installation of approved practices.

### CONSERVATION NEED INVENTORY

The Soil Conservation Service has departmental leadership for a national inventory of soil and water conservation needs. This inventory will

cover all land, private and public, for which the Department has responsibilities for soil and water conservation. It will collect and summarize information on soil resources, probable land-use adjustments, and soil and water conservation treatments needed.

A Territorial committee has been established to guide the conservation needs inventory. Territorial agencies and organizations concerned with soil and water conservation serve on this committee. They are responsible for directing the inventory as a cooperative effort in line with national policies and procedures, for setting up priorities of work, training Island groups, and reviewing and evaluating data.

### RESEARCH

Research in soil and water technology is conducted by the Agricultural Research Service and the Hawaii Agricultural Experiment Station, either individually or through cooperative arrangements. SCS uses pertinent research information from these Federal and Territorial agencies and from other authoritative sources. Except as an integral part of its soil-survey activities SCS does no research.

### INFORMATION AND EDUCATION

Education work with farmers and ranchers on soil and water conservation is carried on through the Extension Service as the designated educational agency of the Department.

In addition, SCS provides information assistance to educational agencies, institutions and organizations on subjects and programs relating to soil



and water conservation. These services include publications; technical consultation as requested; and information services to writers, publishers, and other producers of materials for public use.

The SCS also cooperates with local and Territorial agencies and other organizations, including the Hawaii Association of Soil Conservation Districts in carrying out its information responsibilities as the Department's technical agency in soil and water conservation.

### SMALL WATERSHED PROTECTION

The Soil Conservation Service has administrative leadership for Federal assistance to small-watershed projects under the Watershed Protection and Flood Prevention Act, P.L. 556.

This Act provides for technical and financial assistance by the Department of Agriculture to Territorial and local organizations for land treatment, flood prevention, and the conservation, development, utilization, and disposal of water on watersheds up to 250,000 acres in size.

The Department's contribution to these projects is of three kinds: (1) Technical assistance in planning, designing, and installing works of improvement; (2) sharing costs of flood prevention and agricultural water management; and, (3) extending long-term credit to help local interests with their share of the costs.

These projects are planned for integrated use of all the land and water resources in a watershed. Structural measures can be of three kinds: (1) Flood-prevention measures, which are eligible for Federal assistance up to the full cost; (2) agricultural water-management measures, such as drainage and irrigation or provision for a more uniform supply of water for agricultural use --- which are eligible for Federal technical assistance and cost-sharing; and (3) non-agricultural water-management measures --- such as municipal or industrial water supplies, stream flow regulation, or wildlife and recreational facilities --- for which local interests bear the full costs.

Soil and water conservation measures on the land must precede installation of floodwater-retarding structures and irrigation and drainage facilities.

Small watershed projects are initiated by local organizations having authority to carry them out, operate, and maintain works of improvement under Public Law 566, as amended. Qualified organizations are defined by law and may be the Territory or any instrumentality thereof. Usually the sponsor of a project is a soil conservation district, often in cooperation with a municipality or a county.

The local organization makes an application for assistance to the Secretary of Agriculture. This application is first submitted to the Governor for his approval. As a matter of Department policy no application is acted on until it has his approval.

When a watershed plan has been developed cooperatively by the local organization and interested Territorial and Federal Agencies, it is reviewed in public meetings with representatives of all concerned groups. After a project has been approved by the SCS Administrator, it is returned to the Governor for his final review and comments.

The Act further requires that all work conform with applicable Territorial laws on water rights.

Departmental policy requires that all plans and designs be approved by Territorial agencies under applicable Territorial laws before Federal funds are made available to local organizations for construction.

All work is carried out by the local sponsoring agencies. The Federal Government supplies only technical and financial assistance. Construction, operation, and maintenance are the responsibility of the local agency. It is the policy of the Department and the SCS to cooperate with local, Territorial and other Federal agencies concerned with land and water management to achieve a coordinated effort in this field.

### RESEARCH NEEDS

Design and application of conservation practices has progressed steadily from the first assignment of an SCS technical staff in the Islands in 1938. This staff was redeployed in the war years, 1942-1945, and a completely new start was made in 1946. After passage of the Hawaii Soil Conservation District Act in 1947 and subsequent organization of Soil Conservation Districts, personnel was assigned to meet the increasing work load.

Practices were designed to meet conditions found as well as possible. Research data, farmer experience, and judgment were drawn upon to formulate guides for doing the work. But with the exceedingly varied conditions found in Hawaii, there were few practices that could be standardized to extensive land areas. Extreme differences in soils, climate, elevation, and land use require adapting practices to narrow belts for good planning.



*A 7-inch rain in 3 hours ripped over 6 inches of topsoil from this open and exposed field.*



## TESTS AND TRIALS

Field tests and trials and evaluation studies are undertaken to supplement other data or to seek out clues for more formal investigation. These field activities are developed in collaboration with the Hawaii Agricultural Experiment Station and Extension Service. Aspects of the work included in these categories are: irrigation evaluation studies, infiltration tests, seeding trials, fertilizer tests, forage trials, economic studies of production, soil survey investigations, diversion ditch evaluations, study of small drainage run-off data to determine criteria for spillway and structural design, determination of consumptive-use of water by crops, studies of sealing reservoirs, and study of the effectiveness of various cover crops.

## BROADER PHASES

This requires comprehensive investigation in broader phases involving (1) basic soil problems and availability of plant nutrients, soil structure, and soil-water relationship; (2) water management, irrigation requirements by kinds of crops, effectiveness of sprinklers, efficiency of present systems, and costs of developing supplemental water supplies; (3) soil management, improvement of soil fertility for forage production, management of fine-textured soils, treatment of saline and alkaline soils, use of mulches and cover crops, the climatic influence on crop adaptation; and (4) plant management, pasture establishment in various climatic zones, development of seed resources of desirable grasses and legumes, and brush and weed control.



*Buffel grass has been introduced to many adapted areas where it is really at home.*

Along with research there is a need for determining responses of crops to fertilizer treatments and adaptation and use of plants under farm and ranch conditions.

## SOILS AND SURVEYS

Information on soils of the Islands is available from published reports and from surveys made by the Soil Conservation Service for farm and ranch planning.

"Soil Survey, Territory of Hawaii, Kauai, Lanai, Maui, Molokai and Oahu", Series 1939, No. 25, was issued in September 1955. This is a 644-page report with 30 maps issued jointly by the Soil Conservation Service and the Hawaii Agricultural Experiment Station. Field work for the study was done in the period from 1934-1939. The soils were mapped in varying degrees of detail in proportion to the intensity of land use. The range was from detailed soil surveys in which the soil boundaries were followed throughout their length, to compiled maps in which the basis for delineations were data from previously published material, oral accounts of foresters, farmers and other similar sources other than traverses by trained soil scientists. The detailed surveys give valuable guide lines for agricultural interpretations. Reconnaissance surveys and compiled maps show in a general way the soils of the area but have little value for intensive agricultural programs that require knowledge of soils field by field. The report was written in 1947-1948. Sections of it deal with the natural and cultural setting of Hawaiian soils; soils and their environment; agriculture and soils of Hawaii; and geography and characteristics of soils. The latter section describes families, series, and phases of the great soil groups found in the Islands. Maps are reproduced at a scale of 1:62,500, or 1 inch equals about 1 mile.

## FIELD MAPS

Earlier published information is limited to a report by H. A. Powers, J. C. Ripperton, and Y. B. Goto, "Survey of the Physical Features that Affect the Agriculture of the Kona District of Hawaii", Hawaii Experiment Station Bulletin 66, 1932. Presumably many plantations have field maps of one kind or another to guide them in their operations. These generally are not surveys with defined boundaries and soil descriptions.

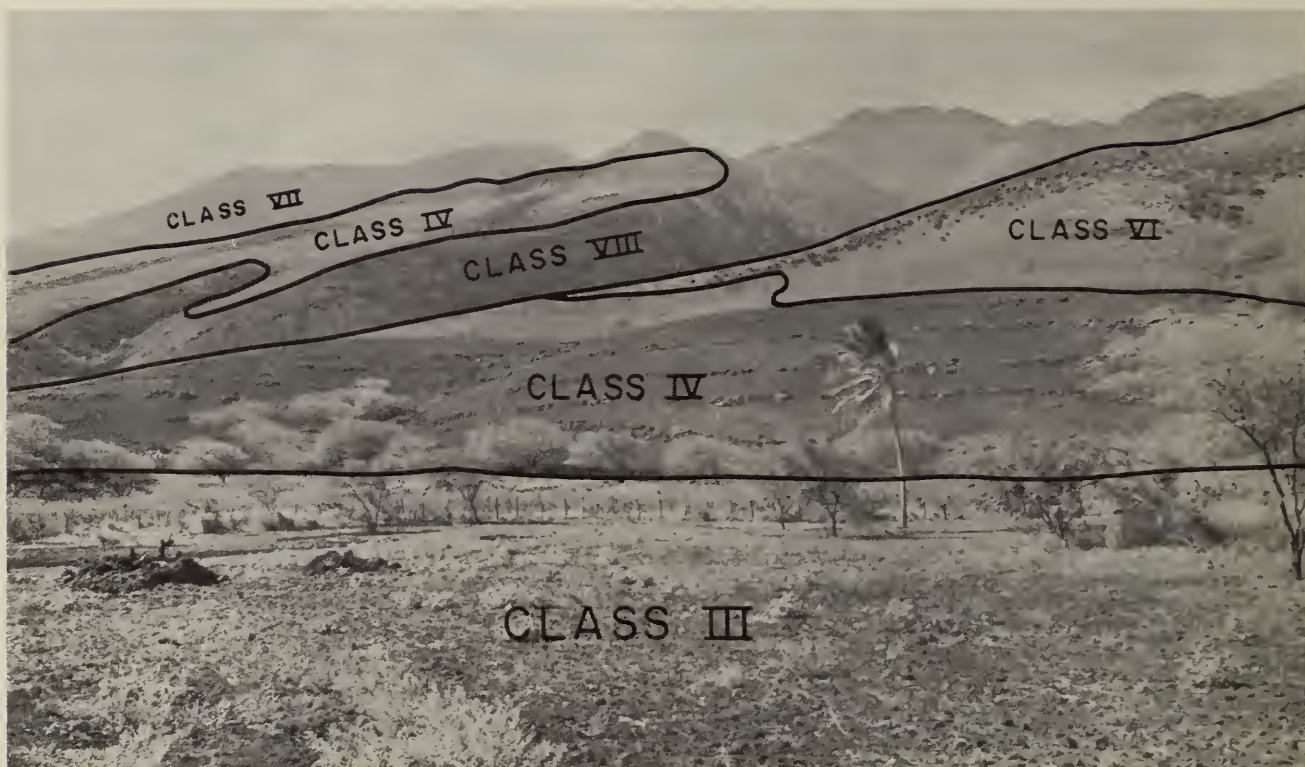
Soil survey work by the Soil Conservation Service in Hawaii in the period 1938-1942 was on a spot basis to provide information for conservation demonstrations then in progress. Also there were reconnaissance surveys on portions of Maui and Hawaii. During the war years soil survey work was discontinued.

## SCS ON JOB

Since reestablishment of the Soil Conservation Service in Hawaii in 1946, surveys have been made as needed for farm and ranch planning. These followed Service standards for the period.

In 1952 the Soil Conservation Service was made responsible for all soil survey activities of the Department of Agriculture. Soil surveys are made





*A soils survey furnishes the information necessary to determine the best uses for each kind of land. Classes I through IV are best suited for cultivated crops. Classes V through VII are best suited for pasture and range. Class VIII is best suited for wildlife and recreation.*

cooperatively with State land-grant colleges and other agencies. To meet the broad needs of the Department of Agriculture the surveys are designed to furnish soil maps and interpretations needed in research and educational programs in technical assistance to farmers and in other programs dealing with soils and soil use. The work includes a nationwide system of soil classification, nomenclature, interpretation, and publication.

Block surveys are scheduled to get better use of survey man-power and to tie in survey areas.

#### CANE LAND SURVEYS

Surveys on sugar plantations deviate from block survey procedures. Surveys on cane land are made on areas where the crop is harvested or the land is being prepared for planting. Since it takes about 18 months to produce a cane crop, surveys on open fields are made in harvest sequence.

As of June 30, 1957, 727,766 acres of conservation survey, 321,746 of standard survey, and 34,541 acres of reconnaissance survey were reported. Resurveys are being made on some earlier survey areas because of inaccurate base maps. Some of these surveys were recorded on planetable base maps. Now aerial photographs are available for all the Islands.

#### TOUGH SPOTS DEFERRED

Not much headway will be made in surveying lands in rain forest areas which are densely covered with trees, brush and fern, and open areas covered with

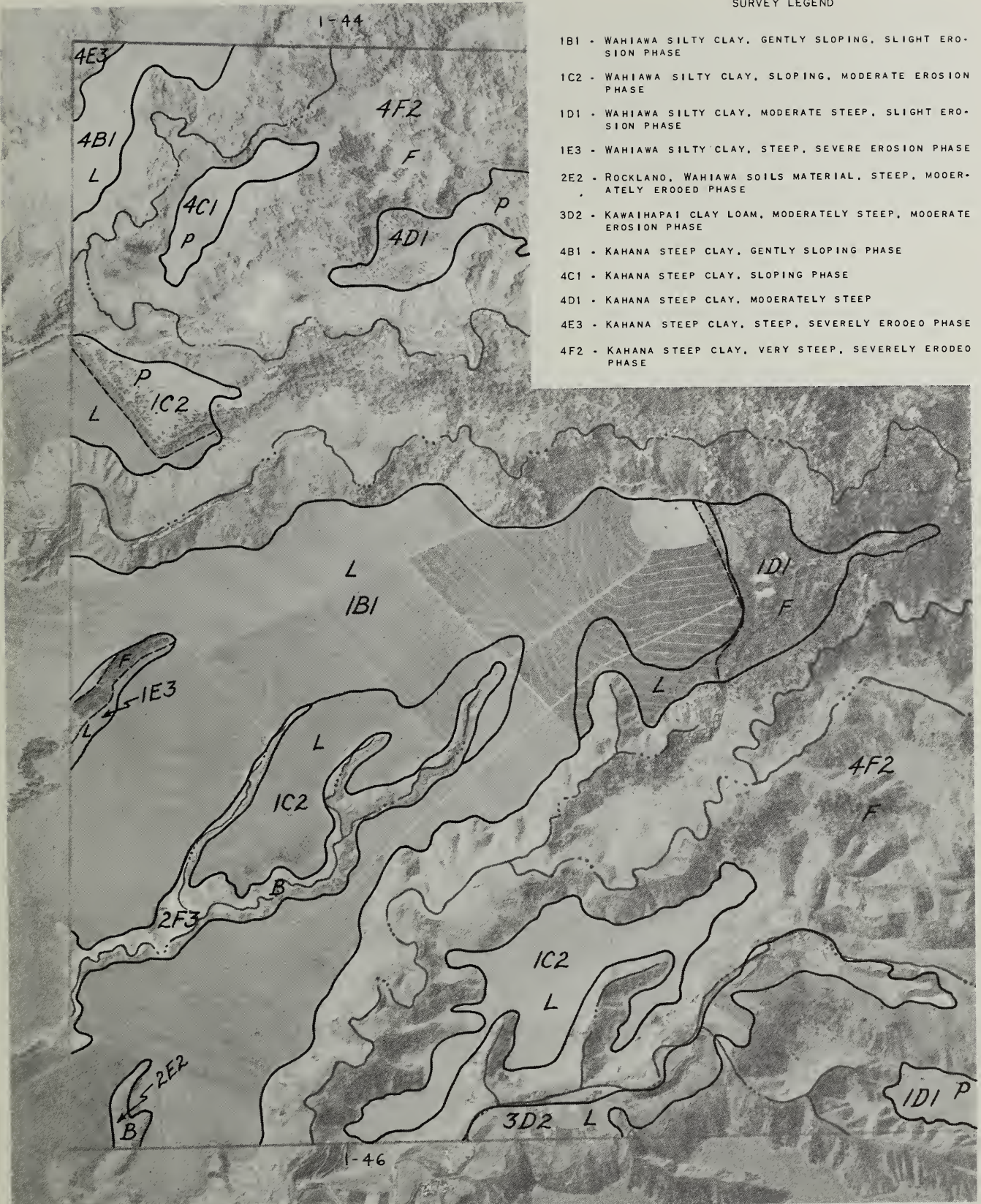


*SCS Soil Scientists making soils survey in recently harvested sugar cane field.*



# SURVEY LEGEND

- 1B1 - WAHIAWA SILTY CLAY, GENTLY SLOPING, SLIGHT EROSION PHASE
- 1C2 - WAHIAWA SILTY CLAY, SLOPING, MODERATE EROSION PHASE
- 1D1 - WAHIAWA SILTY CLAY, MODERATE STEEP, SLIGHT EROSION PHASE
- 1E3 - WAHIAWA SILTY CLAY, STEEP, SEVERE EROSION PHASE
- 2E2 - ROCKLAND, WAHIAWA SOILS MATERIAL, STEEP, MODERATELY ERODED PHASE
- 3D2 - KAWAIHAPAI CLAY LOAM, MODERATELY STEEP, MODERATE EROSION PHASE
- 4B1 - KAHANA STEEP CLAY, GENTLY SLOPING PHASE
- 4C1 - KAHANA STEEP CLAY, SLOPING PHASE
- 4D1 - KAHANA STEEP CLAY, MODERATELY STEEP
- 4E3 - KAHANA STEEP CLAY, STEEP, SEVERELY ERODED PHASE
- 4F2 - KAHANA STEEP CLAY, VERY STEEP, SEVERELY ERODED PHASE



The aerial map is used by the soil surveyor, and by means of symbols, he delineates the several kinds of soil types mapped. With this information, the soil conservationist recommends the best use for each kind of land according to site and climate.



a tangle of staghorn fern. Under present conditions, such areas are impractical and dangerous to survey. As soon as owners clear roads and trails these lands will be included in soil inventories. Party survey schedules are made to complete some of the larger areas, particularly in ranching areas.

A survey, with assistance of a U. S. Marine helicopter unit, was made in an area of very rough terrain in the Kau section of Hawaii. Other equally difficult areas may be inventoried through this facility.

### SURVEY METHODS

Current survey procedures provide adequate information for farm and ranch planning and for needs of other agencies. Surveys are being used by the Hawaii Water Authority to design new projects; Board of Agriculture and Forestry to guide reforestation projects; Territorial Tax Commissioner's Office in a preliminary way in a study of property evaluation; Bishop Estate in renegotiating leases with tenants; Belt Collins and Associates, Ltd., for road construction; and Farmers Home Administration for subdivision information.



*Soils profiles are examined for classification and best use recommendation.*



*SCS Soil Scientist taking soils samples which are used to help determine land protection and use programs.*





*Rancher surveys his grazing lands.*

### SOIL CHARACTERISTICS

Soils of the Islands are derived from volcanic lava, eruptive deposits of ash, tuff, and cinders, alluvial deposits, and marine sediments from coral reefs. Marine sediment formations constitute only a small proportion of the total area. Age and variety of parent materials plus extreme range of rainfall have resulted in a complexity of soils that is hardly equaled in so limited an area anywhere else.

More mature soils are found on Kauai, northernmost island of the group. Soils are progressively younger on the islands southward. The Island of Hawaii, where volcanic eruptions still occur, has great fields of bare lava where soil formation processes have barely started.

Average annual rainfall ranges from 10 inches to over 400 inches. Land is cultivated in areas where rainfall amounts to 280 inches a year. Conditions suitable for temperate-zone crops like plums, apples, peaches, and apricots are found in some farming areas at about 3500 feet elevation. The difference in temperature between the coolest and the warmest month of the year at a given location is usually less than 6.5 degrees.

Most of the soils on the islands are latosols. These are soils that are characterized by the extreme depletion of silica and soluble bases such as calcium. Iron and aluminum have been concentrated throughout the solum because of the removal of bases and combined silica. Typically these soils have horizons that do not have strongly defined physical characteristics. There are, however, marked chemical differences between soil horizons. The latosols are typically red due to the presence of the sesquioxide minerals.

Considering the variety of minerals in parent materials from which soils have been derived, it is not surprising that they vary widely in chemical and physical properties.

### SOIL PROPERTIES

One physical property common to all these soils is the stability of the soil aggregates. They vary in size and feel like sand but break down under pressure. Practically all soils except those derived from coral are clays. This means that more than 40 percent of soil by weight is less than .002 m.m. in size.

A chemical property common to all latosols is the ability to fix great quantities of phosphorus. In laboratory tests one of the higher rates of fixation was 93 milligrams of phosphorus to 100 grams of soil.

### SOIL IMPROVEMENTS

Minor elements have been used for many years to improve production of crops in the Islands. Iron, the first of the group to receive attention, is used regularly on pineapple plantations. It is applied in a soluble form directly to plants throughout the growth and production period.

Crop reaction to minor elements varies by soil groups. In particular locations there is a favorable response to application of iron to macadamia nuts and to truck crops and ornamentals; manganese to sugar cane; molybdenum to legumes; magnesium to macadamia nuts; and boron to alfalfa and truck crops. Manganese toxicity has been noted on truck crops in the Ewa section on Oahu. This is the only instance of this kind that has come to our attention.

Organic matter in soil generally increases with rainfall. In areas of low rainfall the organic matter content is from 2 to 6 percent of the weight of soil. In higher-rainfall areas the amount reaches 27 percent. These ranges are with cultivated soils.



*Each kind of land is surveyed and determination made for its best use--this is pasture land.*



## SOIL ACIDITY

With increased rainfall, soils generally increase in acidity. Under natural conditions pH may be as low as 4.5. Soils generally have high water-intake rates and low moisture-retention capacities. Water-holding capacity may be as high as 500 percent of the soil weight. Infiltration and permeability rates sometimes exceed 25 inches per hour. Bulk densities may be as low as 12 pounds per cubic foot. Infiltration of water into soils in low and moderate rainfall zones is reduced by compaction and puddling; in soils of higher rainfall puddling alone reduces the infiltration rate. The most stable soils have a high proportion of laterite throughout the profile, almost to the point of complete desilicization.

Most of our soils do not have scouring properties. This is due to the low silica fraction in their composition.

## RANGE CONSERVATION

Progress is being made in improving the cover on grazing lands. Native grasses with few exceptions failed to withstand livestock pressure. Many species have been introduced from other lands in an effort to find satisfactory plant materials.

We have now learned that many of the introductions, some deliberate and some accidental, were unfortunate. Herbaceous and shrubby species of low quality rapidly invaded grazing land on the Islands and became pests that inhibit the introduction of better plants. Studies of species adaptation by researchers and ranchers are finding plants that are adapted to most conditions. Further tests of introductions and selections are needed to find improved types.

## SEED MIXTURES

Several legumes are used successfully in mixtures. Koa haole, a shrubby legume, is compatible with Guinea grass; Spanish clover produces well with kikuyu and pangola grass; and kaimi clover is used with kikuyu, pangola, and Dallis grasses. In some plant zones, however, there is a serious need for adapted legumes.

Local production of seed is extremely limited in proportion to the amount required. Kikuyu, pangola, giant Bermuda, Napier, and California grass are propagated by sprigging. Guinea and Bahia grasses, kaimi and Desmodium intortum "clovers", and big trefoil are sprigged or seeded. Buffel, Rhodes, blue panic, molasses, and Dallis grasses and koa haole and Spanish clover are seeded.

## GRAZING LANDS

Almost one-fourth of the land of Hawaii is used for the pasturage of cattle or sheep. Territorial land leased for this purpose accounts for over 659 thousand acres out of the total of 1,022,000 acres. Beef and beef products to the amount of \$7,734,000 originate on these lands. Of the 720 farms and ranches in 1956 reporting beef cattle, only 386 are listed as commercial enterprises, that is, having 20 or more head. Hawaii has the greater number of commercial producers with 195. This was followed by Maui with 93, Oahu with 43, Kauai-Niihau 42 and



*Fertilizing Napier grass with a farm-size spreader.*



*Planting pangola grass on a retired cane field. These vegetative plantings are laid in furrows made by a subsoiler.*



*Sealed water storage reservoirs are efficient ways being developed to meet water storage needs.*



Molokai-Lanai 13. The ratio of the number of cattle on ranches to the number butchered was 24 percent. The value of the beef slaughtered was Hawaii, \$4,897,000; Maui, \$1,276,000; Kauai-Niihau, \$712,000; Oahu, \$696,000; and Molokai-Lanai, \$171,000.

The acreage of land in range or pasture decreased 37 percent in the decade 1947-56, or from 1,619,000 to 1,022,000 acres. In this interval number of cattle increased 15 percent or from 132,800 to 156,800 head. The area used for range and pasture by islands is Hawaii, 643,999 acres; Maui, 158,000 acres; Kauai-Niihau, 122,000 acres; Molokai, 64,000 acres; and Oahu, 35,000 acres.

Grazing lands are in all climatic conditions from seacoast to about the 7,000-foot elevation level. While plant growth may extend to 10,000 feet on the highest peaks, it affords only very limited use because of sparseness of forage and shortage of water. Vegetation in the Islands has been classified by the predominating plants, trees, shrubs, grasses and forbs into vegetation zones. They are represented as bands of xerophytic shrubs, trees and grasses in areas of 20 inches or less rainfall near sea level on the lee sides of the islands to rain forests of trees and tree ferns in areas of 150 inches and above rainfall.

The management of native ranges or of pastures developed from introduced species of grasses and legumes requires a fine understanding of the performance of the various species of plants under the adaptations of the climate and derived soils. Movement of cattle between paddocks to maintain both the livestock and the forage in top condition requires a special knowledge of the area used for grazing purposes. Extremely rocky terrain is fenced to assist in getting proper distribution of livestock. Water is developed even to the extent of pumping brackish water from wells almost at sea level to pastures five to six miles back from the ocean and to an elevation of 4,000 to 5,000 feet. These are but part of the difficult operations that are undertaken in ranch development.



One of the famous old fish ponds of Kaneohe still being used today for raising mullet.

Supplemental feeding of minerals in areas of proven deficiency has helped remarkably in producing high calf crops. Shifting cattle from wet to dry pastures for proper periods of forage use and reserving specially nutritious pastures for fitting the slaughter cattle for market requires keen judgment on the part of the ranch manager. Hawaiian producers are especially alert for ways and methods of increasing the margin of profit on their animals. After all, the costs of production are high and competition with the shipped in Mainland beef is rugged. The Island producer has to follow all angles carefully to improve his pastures, his herd, and his returns on his investment.

## WILDLIFE PROBLEMS

Wildlife problems are not the product of native species but of feral animals and other introductions. Wild sheep, goats, pigs, cattle, and dogs are now pretty well confined to the more rugged areas. Wild sheep and goats are kept under control by hunting. The same is true of axis deer on Molokai and Lanai.

The mongoose, imported to kill rats, didn't perform as expected. It is a diurnal animal whereas the rat is nocturnal. The mongoose causes heavy losses to ground brooding birds.

Ring-necked and green pheasants, doves, quails, and chukar partridges do well in favorable habitats where the nests are not disturbed. Brazilian and Kentucky cardinals, ricebirds, mynahs, white-eyes, house finches, English skylarks, mocking-birds, house sparrows, and occasionally pheasants cause damage to crops. Sometimes damages to vegetables and fruits are serious. Special protective measures are installed on rice paddies to cope with grain-eating birds.



The Hawaiian wild pig furnishes excellent hunting and recreation.



The ring-necked pheasant is fast becoming a popular game bird in Hawaii.





25-year-old stand of Australian Red Cedar in the Kona SCD.



25-year-old Australian Red Cedar--32" diameter. Kona SCD.

### BIOLOGICAL CONTROLS

Biological controls have gained wide acceptance in the Islands. Parasites have reduced the Oriental fruit fly remarkably. The larvae of Cactoblastis cactorum and the mealy-bug, Dactylopus opuntiae, are rapidly reducing the large areas of cactus on Hawaii.

The giant African snail, an importation from the Orient, is expanding its range. In heavily infested areas, the damage is severe. Parasites to cope with the African snail have been introduced.

Specific insects have been liberated to reduce Christmasberry, lantana, and gorse.

A number of irrigation reservoirs are stocked with bass and bluegills, but we have no reports on production. A few streams have freshwater fish, mainly on Kauai. Only a few of the old Hawaiian fishponds are in use. Many which formerly existed have deteriorated by collapse of barriers during storms. Others have filled with soil from adjacent mountain-sides.

### WOODLAND MANAGEMENT

Forestry would seem to warrant a more favorable position in the Islands' economy than it now has. Territorial forest reserves of 819,705 acres and private forest lands of 352,174 acres are producing only a little timber. Forest lands, however, are important in maintaining a good supply of surface and underground water.

The water problem brought about the earliest broad-gauge interest in conservation in Hawaii. Spearhead for the action was the Hawaiian Sugar Planters Association and its subsidiary experiment station. The objective was improvement and protection of the plantations' water supplies.

### TREE TESTS

The experiment station started testing trees from tropical and sub-tropical regions. Adapted species, without particular regard to their econom-

ic importance, were planted to reforest critical watersheds.

This work received further impetus from labor relief programs during the 1930's. The Civilian Conservation Corps planted many trees. During and following World War II, funds for planting crews were severely reduced. Plantings in the biennium ending June 30, 1956, amounted to 195,298 trees on 514 acres of land, in contrast to 2,485,790 trees planted on 4,059 acres in 1936. The total area reforested by direct plantings between 1934 and 1954 is estimated at 29,958 acres.

### TIMBER USES

Production of timber and water are compatible uses under proper management. Koa lumber and fern trunk products are just about the only two materials produced from native species. The Census for 1950 reports \$47,839 of local forest products sold in the year previous. Ohia trees are abundant but problems in milling and carpentering the lumber have limited its usefulness.

On well selected sites, introduced species have shown outstanding production possibilities. These include Norfolk Island pine, Monterey pine, stone pine, redwood, tropical ash, Australian red cedar, silk oak, jacaranda, albizzia, swamp mahogany, teak, yellow poinciana, and monkeypod. These species collectively have a wide range of adaptation. In quantity production they could replace lumber now being imported from the Mainland for structural and building needs and supply materials for furniture or specialty purposes.

### WHAT'S AHEAD

Little is known of the economics of production. Yield tables are not available for making growth estimates, and correlations between soil conditions and growth rates have not been determined. Growth rate of plantings and the adaptabilities of species to varied conditions warrant much more study.

Investment in the development of commercial



*Logging in the Koa forests of Kona.*



timber would seem to have merit on Territorial lands, the larger estates, and plantations. This enterprise might even be profitable on the rougher lands of the smaller owners. A quick crop like Christmas trees would provide an early turnover on the investment. In 1954 about 89,000 trees were shipped to Hawaii to supply the Christmas trade. In 1955 the number was about 65,000 trees and in 1956 about 112,000 were received.

Windbreaks can be used much more than they are now. Single or multiple-row plantings can be established as the conditions demand. Plants favored for this purpose are hibiscus, ironwood, Monterey cypress, swamp mahogany, oleander, panax, seagrape, and others.

### FOREST PLANTINGS

In 1932 the Territorial Forester reported that 20,553 acres of Territorial land needed forest plantings. The area planted since then exceeds that figure by 9,405 acres. Some of the difference is due to inclusion of private lands in forest reserves, as provided for in later Territorial legislation. Plantings since 1898 are estimated at 29,000 acres on Territorial land and 7,000 acres on private land, a total of 36,000 acres.

More recent estimates indicate that 56,999 acres of Territorial land in forest reserves need to be planted. Thirty thousand acres of private land within forest boundaries also needs reforestation. This adds up to 86,000 acres on both types of ownership. In addition a modest estimate of private land outside forest reserve boundaries needing planting is 40,000 acres. Estimates would be much greater if present forest land having a growth of trees or plants of little economic importance were considered for conversion to better species.

### NEW LAND PROSPECTS

An estimated 300,000 acres on the islands of Hawaii and Maui might be brought into crop production. These are exceedingly rocky aa and pahoe flows in a favorable rainfall belt of 80 to 180 inches. Crops being produced on similar land are pasture, macadamia nuts, papayas, coffee and passion fruit.

Before land can be prepared for planting, trees, brush, and ferns must be cleared off. Then land is leveled and rolled. On some areas holes for plants are drilled with a jackhammer, soil is put in holes, fertilizer is applied, and the planting is made. Costs for these operations vary from 200 to 350 dollars per acre. Continued expansion in development of this type of land indicates that operators are optimistic about its adaptation to crop production.

### SALINE SOILS

Another group of soils amounting to about 5,000 acres of undeveloped land are saline soils of alluvial flats and contiguous slopes on Maui, Molokai, Kauai, and Oahu. Experience has already proved their adaptation to crop production. Parts of the Ewa Plantation and the former Waiānae Sugar Company plantation are on this kind of land. For over 50 years Ewa Plantation Company has had a notable record of sugar production.



*Forest and shrub slopes before conversion to high producing pasture and range land in the Molokai SCD.*





*Fertilizing range seedings in the Kau SCD.*



*Completed stockwater pond in the Mauna Kea SCD.*





*Cleaning drainage ditches is a continuing job in a country of high rainfall--rich soils and ideal growing conditions.*



*Placing 24" rock rip rap on the 2:1 slope of an irrigation water reservoir.*



*Irrigated field of sugar cane with irrigation reservoirs at head of the water distribution system.*

## IRRIGATION HELPS

The supply of "safe" water has limited development of these lands for irrigation. However, great quantities of usable water can be made available by intercepting water flowing from underground lenses. Wells have been drilled to tap these supplies with variable results. Some wells produced strongly brackish water, and others, water suitable for use. Extensive studies have been made of underground water resources and criteria on depth and placement now guide drilling to intercept these flows.

Recently the open trench well has been used by Molokai Ranch Company. The lower level of the cut is slightly above mean sea level and water carries about 80 grains of total salts per gallon. By applying this in proper amounts these saline soils can be cropped. In tests, a large variety of vegetables, fruits, flowers, grasses, and seeds were produced with 100-grain water. This is about the same quality water being used on portions of Ewa Plantation Company lands.

## STUDY NEEDED

Before irrigation developments are undertaken, the following items should be studied: character and amount of water supply, depth of soil to the water table, factors of clearing and land preparation, layout of the distribution system, and choice of crops to be grown.

Surveys and studies were under way on seven irrigation projects by Hawaii Water Authority by the end of 1956. Locations were: Waimanalo, Oahu; Waimea, Hawaii; Molokai; Reservoir, Kawaihae II, South Kohala, Hawaii; Kula, Maui; Kokee, Kauai; and Waianae, Oahu.



Irrigation water is needed for a large part of cultivated acreage in Hawaii. Proportionately less cropland is irrigated on the Island of Hawaii than elsewhere. Areas benefitting from irrigation on the Big Island are in North Kona, North and South Kohala, and Hamakua sections.

The upper valleys on all the islands generally have adequate rainfall for truck, fruit crops, and flowers.

### WATER USES

Pineapple companies have found that small amounts of water added during May, June, July and August, or in periods of extended drought as in 1952-53, produce a more uniform crop with less fluctuation of yield.

Of 117,418 acres of irrigated land reported in the 1950 Census, 112,237 acres were on 43 farms (plantations) of 260 acres or more. Total number of farms reporting irrigated acreage was 1,158. Of these 765 were under 10 acres.

Irrigation water for cane is distributed by gravity. Recently, new-type sprinkler irrigation equipment has been introduced experimentally on two sugar plantations.

Water for pineapples is distributed by portable sprinkler systems, by sprinklers from tank trucks, or from tractor-mounted sprinkler booms fed by flexible pipe.

Sprinkler irrigation is gaining in popularity with truck, fruit, and flower producers.

Irrigated pastures provide year-round production and smooth out seasonal fluctuations in production.

Mulching has proved a big help as a water-saving practice in addition to its value for erosion control.



*The Redwood tanks are used to provide water for livestock in areas of highly pervious soil.*

### WET LANDS

We estimate that 1,830 acres of land can be improved by drainage. These lands are mostly on coastal sections of Oahu and Kauai. Co-ordinate action is needed by the land operators to provide rights-of-way for main channels. Outletting water frequently requires the cooperation of the highway department to provide adequate culvert capacities.

Extensive drainage systems are in operation on sugar plantations on alluvial flats on the coasts. Pumping systems are installed to take off the brackish water.

Other engineering activities involve designs for pumping layouts, for construction of reservoirs with lined or unlined surfaces, and for water-interception structures above or within cultivated areas.



*Well planned structures such as this diversion dam firming up the water distribution systems of the Islands.*





*Sprinkler irrigation on alfalfa lands in the Molokai SCD.*



*Shallow scooped out type of well used for pasture, fruit, truck crop irrigation. Molokai SCD.*



*Grassed waterway of Argentine Bahia grass in the Olinda-Kula SCD.*



# Youth and Conservation Education

The education of youth in the protection and improvement of our Nation's natural resources isn't confined to Mainland U. S. A. Hawaii is seeing that tomorrow's citizens become fully aware of the heritage that will be theirs.

Vocational agriculture instruction is given in 24 of the 27 high schools in the Islands. Winning speakers have consistently won top places with soil conservation as their subject. An Island boy, Liberato C. Viduya, Jr., placed first in the oratorical contest finals at Kansas City in 1955. His subject was "The Soil, Stepping Stone to Freedom."

Boys and girls 4-H clubs are learning more about our soil resources through land judging contests. Grade and high school instruction is given in conservation subjects. This is sometimes supplemented with field trips to observe land conditions. Basic instruction in conservation is given in the Teachers College, the College of Agriculture, and in courses in geography and economics at the University of Hawaii. Boy Scout troops have taken on jobs of tree planting to heal erosion scars as special conservation projects.



*Intense interest by 4-H Club members at land judging contest.*





*Boy Scouts taking instructions for soil and water conservation merit badge.*

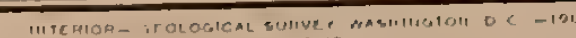


*Boy Scouts have assisted in tree planting projects to heal erosion scars in critical areas.*









Populated areas revised from 1951-52 photography. Map field checked in 1952.

